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DUBLIN:

Printed by and for I. JACKSON and Son, at the *Globe* in *Aleath-ſtreet.* 1769.

TO his much honoured Friends, *Manwaring Davis* of the *Inner Temple*, Eſq; and Mr. *Humphry Davis* of St. *Mary Newington Butts*, in the County of *Surry*, *John Hawkins*, as an Acknowledgment of unmerited Favours, humbly dedicateth this *Manual of Arithmetick*.

To the READER.

Courteous Reader,

I Having had the Happineſs of an intimate Acquaintance with Mr. *Cocker* in his Life-time, often ſollicited him to remember his Promiſe to the World, of publiſhing his *Arithmetick*; but (for Reaſons beſt known to himſelf) he refuſed it; and after his Death (the Copy falling accidentally into my Hand) I thought it not convenient to ſmother a Work of ſo conſiderable a Moment, not queſtioning but it might be as kindly accepted as if it had been preſented by his own Hand. The Method is familiar and eaſy, diſcovering as well the Theoric as the Practic of that neceſſary Art of *Vulgar Arithmetick*. And in this new Edition there are many remarkable Alterations for the Benefit of the Teacher or Learner, which I hope will be very acceptable to the World. I have alſo performed my Promiſe, in publiſhing the *Decimal Arithmetick*, which finds Encouragement to my Expectations, and the Bookſellers too. I am thine to ſerve thee,

John Hawkins.

AT the Requeſt of Mr. *Jackſon*, I have examined this new Edition of *Cocker*'s Arithmetic: I believe ſcarce any of the Errors complained of in the former Impreſſions have paſſed without Amendment, and the Learner may now depend on its Correctneſs.

May 31,
1757. *G. Mint*

Mr. Edward Cocker's

PROEM or PREFACE.

BY the ſecret Influence of Divine Providence, I have been inſtrumental to the Benefit of many, by Virtue of theſe uſeful Arts, Writing *and* Engraving: *And do now with the ſame wonted Alacrity, caſt this my Arithmetical Mite into the publick Treaſury, beſeeching the Almighty to grant the like Bleſſing to theſe as to my former Labours.*

Seven Sciences ſupremely excellent,
Are the chief Stars in *Wiſdom*'s Firmament:
Whereof *Arithmetick* is one, whoſe Worth
The Beams of Profit and Delight ſhine forth;
This crowns the reſt, this makes Man's Mind compleat,
This treats of Numbers, and of this we treat.

I have been often deſired, by my intimate Friends, to publiſh ſomething on this Subject, who, in a pleaſing Freedom, have ſignified to me, that they expected it would be extraordinary. How far I have anſwered their Expectation I know not; but this I know, that I have deſigned this Work not extraordinary abſtruſe or profound, but have, by all Means poſſible, within the Circumference of my Capacity, endeavoured to render it extraordinary uſeful to all theſe, whoſe Occaſions ſhall induce them to make uſe of Numbers. *If it be objected, That the Books already publiſhed, treating of* Numbers, *are innumerable; I anſwer, That's but a ſmall Wonder, ſince the Art is infinite. But that there ſhould be ſo many excellent Tracts of* Practical Arithmetick *extant, and ſo little practiſed, is to me a great Wonder; knowing, that as* Merchandize *is the Life of the Weal publick, ſo* Practical Arithmetick *is the Soul of* Merchandize. *Therefore I do ingenuouſly profeſs, that in the Beginning of this Undertaking, the numerous Concerns of the honoured*

Merchant firſt poſſeſſeth my Conſideration: And how far I have accommodated this Compoſure for his moſt worthy Service, let his own profitable Experience judge.

Secondly, *For your Service, moſt excellent Profeſſors, whoſe Underſtandings ſoar to the Sublimity of the Theory and Practice of this noble Science, was this Arithmetical Tractate compoſed; which you may pleaſe to employ as a Monitor to inſtruct your young* Tyroes, *and thereby take Occaſion to reſerve your precious Moments, which might be exhauſted that Way, for your more important Affairs.*

Thirdly, *For you the ingenious Offspring of happy Parents, who will willingly pay the full Price of Induſtry and Exerciſe for thoſe Arts and choice Accompliſhments, which may contribute to the Felicity of your future State: For you, I ſay, (ingenious Practitioners) was this Work compoſed, which may prove the Pleaſure of your Youth, and the Glory of your Age.*

Laſtly, *For you the pretended Numeriſts of this vapouring Age, who are more diſingeniouſly witty to propound unneceſſary Queſtions, than ingenuouſly judicious to reſolve ſuch as are neceſſary; for you was this Book compoſed and publiſhed, if you will deny yourſelves ſo much as not to invert the Streams of your Ingenuity, but by ſtudiouſly conferring with the Notes, Names Orders, Progreſs, Species, Properties, Proprieties, Proportions, Powers, Affections and Applications of* Numbers *delivered herein, become ſuch Artiſts indeed as you now only ſeem to be, This* Arithmetick, *ingeniouſly obſerved and diligently practiſed, will turn to good account to all that ſhall be concerned in Accompts, ſince all its Rules are grounded on Verity, and delivered with Sincerity; the Examples built up gradually from the ſmalleſt Conſideration to the greateſt; and all the Problems or Propoſitions well weighed, pertinent and clear, and not one of them throughout the Tract taken upon Truſt, therefore, now,*

Zolius and *Momus* lie you down and die,
For theſe Inventions your whole Force defy.

Edward Cocker.

Courteous Reader,

BEing well acquainted with the deceaſed Author, and finding him knowing and ſtudious in the Myſteries of Numbers and Algebra, of which he had ſome choice Manuſcripts, and a great Collection of printed Authors in ſeveral Languages, I doubt not but he hath wit his Arithmetick ſuitable to his own Preface, and worthy Acceptation, which I thought fit to certify, on a Requeſt to that Purpoſe, made to him that wiſheth thy Welfare, and the Progreſs of Arts.

Nov. 27. 1677. *John Collens.*

This Manual of Arithmetick *is recommended to the World by us whoſe Names are ſubſcribed,* viz.

Mr. John Collens, *Mr.* James Atkinſon, *Mr.* Peter Perkins } *Math.*
Mr. Rich. Lawrance, *Sen.*
Mr. Eleazar Wigan
Mr. Rich. Noble *of Gilford*
Mr. William Norgate
Mr. William Maſon
Mr. Stephen Thomas
Mr. Peter Storey
Mr. Benj. Tichbourn
Mr. Joſeph Symmonds
Mr. Jerem. Miles
Mr. Joſiah Cuffley
Mr. John Hawkins

And generally approved by all ingenious Artiſts.

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CHAP. I.

Notation of Numbers.

ARITHMETICK is an Art of Numbering, or Knowledge, which teacheth to number well. And there are divers Species and Kinds of *Arithmetick* and *Geometry*, the which we do intend to treat of in Order, applying the Principles of the one to the Definition of the other. For as Greatneſs is the Subject of *Geometry*, ſo Number is the Subject of *Arithmetick*; and if ſo, then their firſt Principles and chief Fundamentals muſt have like Definitions, or at leaſt ſome Congrueney.

2. Number is that by which the Quantity of any Thing is expreſſed or numbered; as the Unit is the Number by which the Quantity of one Thing is expreſſed or ſaid to be one, and two, by which it is named two, and $\frac{1}{2}$ half, by which it is named or call half, and $\sqrt{\ }3$ the Root of 3, by which it is call the Root of 3; the like of any other.

3. Hence it is that Unit is Number; for the Part is of the ſame Matter that is its Whole, the Unit is part of the Multitude of Units, therefore the Unit is of the ſame Matter, that is the Multitude of Units; but the Matter of the Multitude of Units is Number; therefore the Matter of Unit is Number; or elſe, if from a Number given no Number be ſubtracted, the Number given remaineth; as ſuppoſe 3 the given Number; if, as ſome ſuppoſe, 1 to be no Number, then if you ſubtract 1 from 3, there muſt remain three ſtill; which is very abſurd.

4. Hence it will be convenient to examine from whence Number hath its Riſe or Beginning. Moſt Authors maintain, that Unit is the Beginning of Number, and itſelf no Number; but looking upon the Principles and Definitions in the firſt Rudiments of Geometry, we ſhall find that the Definition of a Point is no way congruous with the Definition of an Unit in Arithmetick; and therefore One or Unit muſt be in the Bounds or Limits of Number, and conſequently the Beginning of Number is not to be found in the Number 1; whererefore making Number and Magnitude congruent in Principles, and like in Difinitions, we make

and conſtitute a Cypher to be the Beginning of Number, or rather the Medium between encreaſing and decreaſing Numbers, commonly called abſolute or whole Numbers, and negative and fractional Numbers, between *which* nothing can be imagined more *agreeable* to the Diſinition of a Point in Geometry; for as a Point is an Adjunct of a Line, and itſelf no Line, ſo is a (o) Cypher an Adjunct of Number, and itſelf no Number: And as a Point in Geometry cannot be divided or increaſed into Parts, ſo likewiſe (o) cannot be divided or increaſed into Parts; for as many Points, tho' in Number infinite, do make no Line, ſo many (o) Cyphers, tho' in Number infinite, do make no Number. For the Line A B cannot be increaſed by the Addition of the Point C, neither the Number D be increaſed by the Addition of the (o) Cypher E; for if you add nothing to 6. the Sum will be 6, (o) Cypher neither increaſing nor diminiſhing the Number 6; but if it be granted that A B be extended or prolonged to the Point C, ſo that A C be made a continued Line, then A B is increaſed by the Addition of the Point C. In like manner, if we grant D (6) to be prolonged to E (o), ſo that D E (60) be a continued Number, making 60, then (6) is augmented by the Aid of (o) as conſtituting the Number (60) Sixty: And furthermore, that 1 or Unit is material, in a Number, and that (o) is the Beginning of Number, is proved by all Authors, altho' indirectly; for the Tables of Sines and Tangents prove one Degree to be a Number, becauſe the Sine of 1 Degree is 174524, (the Radius being 1000000) and the Beginning of the Table is (o), and it anſwereth 000000, *&c.*

A-------B
C
D 6
E o

Sum of 6

A---B---C
D E 06
60

5. Hence it is that Number is not Quantity diſcontinu'd for that which is but one Quantity, is not Quantity diſjunct: 60 Sixty, as it is a Number, is one Quantity, *viz.* one Number (60) ſixty; threrefore as it is a Number, it is not Quantity disjunct, for Number is ſome ſuch Thing in Magnitude; as Humidity in Water; for as Humidity extends itſelf thro' all and every part of Water, to Number related to Magnitude doth extend itſelf thro' all and every part of Magnitude: Alſo, as continued Water doth anſwer continued Humidity, ſo to a continued Magnitude doth anſwer a continued Number. As the continued Humidity of an entire Water ſuffereth the ſame Diviſion and Diſtinction that his Water doth, ſo the continued Number ſuffereth

eth the ſame Diviſion and Diſtinction that his magnitude doth. And thus much concerning the Definition and Principles of Number and Magnitude. We come now to treat of,

6. The Characters or Notes by which Numbers are ſignified, or by which a Number is ordinarily expreſſed; and they are theſe, *viz.* (0) Cypher or Nothing, 1 One, 2 Two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven, 8 Eight, 9 Nine. The Cypher, which tho' of itſelf it expreſſeth not any certain or known Quantity, yet is the Beginning or Root of Number, and the other nine Figures are called ſignificant Figures of Digits.

7. In Number of any Sort two Things are to be conſidered, *viz.* *Notation* and *Numeration.*

8. *Notation* teacheth how to deſcribe any Number by certain Notes and Characters, and to declare the Value thereof, being ſo deſcribed, that is by Degrees and Periods.

9. A Degree conſiſts of 3 Figures, *viz.* of three Places, comprehending Units, Tens and Hundreds, ſo 365 is a Degree, and the firſt Figure (5) on the right-Hand, ſtands ſimply for its own Value, being Units, or ſo many Ones, *viz.* five; the ſecond in Order from the Right, ſignifies as many times Ten as there are Units contained in it, *viz.* ſixty; the third in the ſame Order ſignifies ſo many Hundreds as it contains Units, ſo will the Expreſſion of the Number be Three hundred ſixty five, *&c.*

10. A Period is when a Number conſiſts of more than 3 Figures or Places, and whoſe proper Order is to prick every third Place, beginning at the right Hand, and ſo on to the left; ſo the Number 63452 being given, it will be diſtinguiſhed thus, 63,452, and expreſſed thus, ſixty three thouſand four hundred fifty two; likewiſe 4,578,236,782, being diſtinguiſhed as you ſee, will be expreſſed thus, four thouſand five hundred ſeventy eight millions, two hundred thirty ſix thouſand, ſeven hundred eighty two.

11. Number is either Abſolute or Negative.

12. Abſolute, intire, whole, increaſing Number, is that by which annexing another Figure or Cypher, it becomes ten times as much as it ſtood for before; and if two Figures or Cyphers be annexed, it makes an hundred times as much as it ſtood for before, *&c.* as if you annex to the Figure 6 a Cypher, then it will be (60) ſixty; ſo if two Cyphers are annexed, then it will be (600) ſix hundred, and if you do annex to it (4) four, then it will be (64) ſixty four, an if you annex (78) ſeventy eight, it will be then (678) ſix hundred ſeventy eight. *&c.*

13. A negative or broken, fractional, decreasing Number, is that by which prefixing a Point or Prick toward the left Hand, its Value has decreased from so many Units to so many tenth Parts of any Thing; and if a Point and (0) Cypher, or Digit, be prefixed, it will be then so many hundred Parts; and if a Point and two Cyphers or Digits be prefixed, its Value is decreased to be so many thousandth Parts; as if you would prefix before the Figure 3 a Point (.) or Prick thus (.3) it is then decreased from 3 Units or 3 Integers, to 3 tenth Parts of an Unit or an Integer; and if you prefix a Point and Cypher thus (.03) it is decreased from 3 Integers to 3 hundred Parts of an Integer; and by this Means 5*l.* absolute, by prefixing of a Point, will be decreased to .5*l.* negative, which is 5 tenth Parts of a Pound, equal in value to ten Shillings, and so by prefixing of more Cyphers or Digits, its Value is decreased in a decuple Proportion *in infinitum*. As in the following Scheme, or rather Order of Numbers, we have placed (0) Cypher in its due Place in Order, as it is in the Beginning and Medium of Number; for going from (0) towards the left Hand, you deal with intire, absolute, whole, increasing Numbers

Increasing Numbers.					Decreasing Numbers.			
25	629	876	543	21012	345	678	976	3
mm	mmm	mmm	mmm	CXUXC	mmm	mmm	mmm	m
mm	mmm	mmm	Cx		xC	mmm	mmm	m
mm	mmm	CX				xC	mmm	m
mm	CX						xC	m
X								M

But going from (0) the Place of Units towards the right Hand, you meet with broken, negative, fractional and decreasing Numbers. And hence it follows, that *Multiplication* increaseth the Product in absolute Numbers, but decreaseth the Product in negative Numbers; also Division decreaseth the Quotient in whole Numbers, and increaseth it in negative fractional Numbers.

14. An absolute intire, whole, increasing Number, always has a Point annexed towards the right Hand; and therefore,

15. A negative, broken, decimal, decreasing Number, hath always a Point prefix'd towards the left Hand. When we express Integers or whole Numbers, as 5 *Pounds*, 5 *Feet*, 26 *Men*, we usually annex a Point or Prick after the Number, thus,

l. feet, men. inch.
5. 5. 26. 347.

But

But when we expreſs Decimals, or Numbers that are denied to be intire, or decreaſing Number, we do commonly prefix a Point or Prick before the ſaid Decimal or decreaſing Number, thus (.3) that is, 3 Tenths, or 3 Primes (.03) that is 3 Hundredths, or 3 Seconds.

16. A whole or abſolute Number is a Unit, or a compoſed Multitude of Units, and it is either a Prime or elſe a compound Number.

17. Prime Numbers amongſt themſelves, are thoſe which have no Multitude of Units for a common Meaſure, as 8 and 7, or 10 and 13, becauſe not any Multitude of Units can equally meaſure or divide them without a Remainder.

18. Compound Numbers amongſt themſelves are thoſe which have a Multitude of Units for a common Meaſure, as 9 and 12, becauſe 3 meaſures them exactly, and abbreviates them to three and four.

19. A broken Number, commonly called a Fraction, is a Part or Parts of a whole Number, *viz.* A Part of an Integer, as $\frac{1}{3}$ one Third, is one third Part of an Unit.

20. A broken Number or Fraction conſiſts of two Parts, *viz.* the Numerator and Denominator.

21. The Numerator and Denominator of a Fraction are ſet one over the other, with a Line between them; and the Numerator is ſet above the Line, and expreſſeth the Parts therein contained.

22. The Denominator of a Fraction, is the inferior Number placed below the Line, and expreſſeth the Number of Parts, into which the Unit or Integer is divided; and let $\frac{3}{4}$ be the Fraction given, ſo ſhall 3 be the Numerator, and doth expreſs or number the Multitude of Parts contained in this Fraction; for $\frac{3}{4}$ is a Fraction compounded of Fourths or Quarters, and the Figure 3 in numbering ſhews us, that in that Fraction there are 3 of the 4 Parts or Quarters, alſo in the ſame Fractions, 4 is the Denominator, and doth expreſs the Quality of the Fraction, *viz.* that the Whole or Integer is divided into 4 equal Parts.

23. A broken Number is either proper or impoper, *viz.* proper when the Numerator is leſs than the Denominator, for $\frac{3}{4}$ is a perfect proper Fraction, but an improper Fraction hath its Numerator greater, or at leaſt equal to the Denominator, thus $\frac{8}{8}$ is an improper Fraction, the Reaſon is given in the Definition.

24. A

24. A proper broken Number is either ſimple or compound, *viz.* ſimple when it hath one Denomination, and compound when it conſiſteth of divers Denominations; if $\frac{3}{4}$, $\frac{6}{12}$, $\frac{25}{100}$ were given, we ſay they are each of them ſingle or ſimple Fractions, becauſe they conſiſt but of one Numerator and one Denominator; but if $\frac{3}{4}$ of $\frac{6}{12}$ of $\frac{25}{100}$ of a Pound ſterling where given, we ſay that it is a compound broken Number or Fraction, becauſe the Expreſſion and Repreſentation conſiſteth of more Denominations than one, and ſuch by ſome are called Fractions of Fractions; they have always this Particle (of) between them.

25. When a ſingle broken Number or Fraction hath for his Denominator a Number conſiſting of a Unit in the firſt Place towards the left Hand, and nothing but Cyphers from the Unit towards the right Hand, it is then the more aptly and rightly called a Decimal Fraction; under this Head are all our decreaſing Numbers placed, and in our 13th Definition, called Negative; and by the Order there preſcribed, we order them to be Decimals, by ſigning a Prick or Point before them, or the Numerator, rejecting the Denominator; therefore according to our laſt Rule, $\frac{5}{10}$ $\frac{5}{100}$ $\frac{25}{1000}$, are then ſaid to be decimals; and a Decimal Fraction may be expreſſed without its Denominator (as before) by prefixing a Point or Prick before the Numerator of the ſaid Fraction and then ſhall the former Fractions $\frac{5}{10}$ and $\frac{25}{1000}$ ſtand thus, .5. and .025.

But oftentimes, as in the ſecond and fourth Fractions, $\frac{5}{100}$ and $\frac{25}{10000}$, a Prick or Point will not do without the Help of a Cypher or Cyphers prefixed before the ſignificant Figures of the Numerator, and therefore when the Numerator of a Decimal Fraction conſiſteth not of ſo many Places as the Denominator hath Cyphers, fill up the void Places of the Numerator with prefixing Cyphers before the ſignificant Figures of the Numerator, and then ſign it for a Decimal, ſo ſhall $\frac{5}{100}$ be .05, and $\frac{25}{10000}$ will be .025, and $\frac{72}{10000}$ will be .0072. Now by this we may eaſily diſcover the Denominator; having the Numerator, for always the *Denominator* of any Decimal Fraction conſiſts of ſo many Cyphers as the Numerator hath

ath Places, with an Unit prefixed before the ſaid Cyphers, *viz.* under the Point or Prick.

26. A Decimal Number or Fraction, is expreſſed by Primes, Seconds, Thirds, Fourths, *&c.* and its Number decreaſing. Here inſtead of natural and common Fractions, as $\frac{3}{4}$ of a Thing, we order the Thing or Integer into Primes, Seconds, Thirds Fourths, Fifths, *&c.* that our Expreſſion may be conſonant to our former Order.

27. In Decimal Arithmetick we always imagine that all intire Units, Integers and Things are divided firſt into ten equal Parts, and theſe Parts ſo divided we call Primes, and Secondly, we divide alſo each of the former Primes into other ten equal Parts, and every one of theſe Diviſions we call Seconds; and Thirdly, we divide each of the ſaid Seconds into ten other equal Parts, and thoſe ſo divided we call Thirds; and ſo by decimating the former, and ſubdecimating theſe latter, we run on *ad infinitum.*

28. Let a Pound *ſterling*, *Troy-weight*, *Averdupois-weight*, *Liquid-meaſure*, *Dry-meaſure*, *Long-meaſure*, *Time*, *Dozen*, or any other Thing or Integer be given to be decimally divided: In this Notion premiſed, we ought to let the firſt Diviſion be Primes, the next Diviſion Seconds, the next Thirds, *&c.* ſo one Pound *ſterling* being 20 Shillings, which divided into ten equal Parts, the Value of each Part will be two Shillings, therefore one Prime of a Pound *ſterling* will ſtand thus (.1) which is in Value 2 Shillings, 3 Primes will ſtand thus (.3) and that is in Value 6 Shillings. Again, a Prime, or .1 being divided into ten equal Parts, each of thoſe Parts will be one Second, and is thus expreſſed (.01) and its Value will be found 2*d* Farthing and $\frac{6}{10}$ of a Farthing; and ſo will .05 ſignifiy one Shilling or five Second: And if .01 be divided into ten other equal Parts, each of thoſe Parts ſo divided will be Thirds, and will ſtand thus .001, and its Value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing, and .009 Thirds will be 2*d.* and .64 of a Farthing, or $\frac{64}{100}$ of a Farthing; ſo that .375*l.* will be found to repreſent 7*s.* 6*d.* for the 3 Primes are 6*s.* and the 7 Seconds are 1*s.* 4*d*, and $\frac{8}{10}$ of a Penny, and the 5 Thirds are 1 Penny $\frac{2}{10}$ of a Penny, both which added together make 7*s.* 6*d.*

29. If you put any Bulk or Body repreſenting an Integer, and it be decimally divided, then the Parts in the firſt

Decimation

Decimation are Primes, the next Seconds, and the nex Decimation is Thirds, the next Fourths, *&c.* As let ther be given a Bullet of Lead, or ſuch like, whoſe Weight I it be 50lb *Troy*, this is called an Unit, Integer or Thing then will the like Weight and Matter make 10 other, th which together will be equal to 50lb and will weigh eac of them 5lb a-piece; take of the ſame Matter, and equa to 5lb make 10 more, then each of thoſe weigh 10 Ounce a-piece; alſo, if again you take 6 Ounces and thereof mak 10 other ſmall Bullets, each of them will weigh 12 Penny-weight *Troy*; and thus have you made Primes, Seconds and Thirds, in reſpect of the Integer, containing 50lb *Troy weight*; ſo that 5 Primes is equal to the half Maſs, and 2 Primes, and 5 Seconds is a quarter of the Maſs; and therefore one of the firſt Diviſion, two of the ſecond Diviſion, and five of the third Diviſion, will be equal in Weight to half a quarter of the Maſs, and contains 6lb 3*oz.*

30. When a decimal Fraction followeth a whole Number, you are to ſeparate or part the Decimal from the whole Number by a Point or Prick; ſo if .75 follow the whole Number 32, ſet them thus, 32.75. You ſhall find that divers Authors have diverſe Ways in expreſſing mix'd Numbers as thus, 32|75, or 32|$\frac{75}{100}$, or 32|75 but you will find that 32.75, thus placed and expreſſed, is the fitteſt for Calculation.

31. A mix'd Number hath two Parts, the whole and the broken; the whole is that which is compoſed of Integers and the broken is a Fraction annexed thereunto. So the mix'd Number 36$\frac{8}{12}$ being given, we ſay, that 36 is the whole Number, which is compoſed of Integers, and the $\frac{8}{12}$ is the broken Number annexed, which ſheweth that one of the former Integers (of that 36) being divided into 12 Parts, this $\frac{8}{12}$ doth expreſs 8 of thoſe 12 Parts more belonging to the ſaid 36 Integers.

32. Denominative Numbers are of one, or of many, and thoſe are of divers Sorts and Kinds, *viz.* Singular, called Unit, as 1; and Plural a Multitude, as 2, 3, 4, 5: Single, of one Kind only called Digits, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and Compounds of many, 10, 11, 12, *&c.* 102, 367, *&c.*

Proportional, as Single, Multiple, Double, Triple, Quadruple *&c.* Denominate, as Pounds Shillings, Pence; Undenominate, as 1, 2, 3, *&c.* Perfect, as 6, 28

126, 8128, 130816, 20999128, *&c.* whoſe Parts are equal to the Numbers; imperfect, unequal, and more than the Sum, as 12, to 1, 2. 3, 4, 6; Imperfect, unequal, and leſs than the Sum, as 8 to 1, 2, 4, : Numbers commenſurable and incommenſurable, as 12 and 9 are commenſurable, becauſe 3 meaſures them both; but 6 and 17 are incommenſurable, becauſe no one common Number or Meaſure can meaſure them; Linear, in form of a Line, as ..... : Superficial, in form of a Superficies or Plane, as ::::: or : : : : *&c.* and Number cubical or ſolid, in form of a Cube: Theſe two latter are otherwiſe called figurative Numbers. There are alſo other Numbers called tabular, as Sines, Tangents, Secants *&c.* others that be called Logarithmical, or borrowed Numbers, fitted to Proportion for Eaſe, and ſpeedy Calculation of all manner of Queſtions.

CHAP. II.

Of the natural Diviſions of Integers, and the ſeveral Denominations of the Parts.

1. AND that we may advance methodically herein, we will begin with the main Pillars on which Arithmetick is founded, *viz*, the ſeveral Species of that Art: But firſt,

Of Money, Weights, &c.

2. The leaſt Denomination or Fraction of Money uſed in *England* is a Farthing, from which is produced the following Table, called the Table of Coin, *&c.*

			And therefore,			
1 Farthing		1 Farthing	*l.*	*s.*	*d.*	*qrs.*
4 Farthings	make	1 Penny	1	20	12	4
12 Pence		1 Shilling	1	20	240	960
20 Shillings		1 Pound		1	12	48
					1	4

The firſt of theſe Tables, *viz.* that on the left Hand, is plain and eaſy to be underſtood, and therefore wants no Direction. In the ſecond Table above the Line, you have *1l.* 20*s.* 12*d.* 4*qrs.* whereby is meant, that 1 Pound is equal to 20 Shillings, and 1 Shilling is equal to 12 Pence, and 1 Penny equal to 4 Farthings; under that Line is *1l.* 20*s.* 240*d.* 960*qrs.* which ſignifies *1l.* to contain 20 Shillings, or 240 Pence, or 960 Farthings; in the ſecond Line below that is *1s.* 12*d.* 48*qrs.* the firſt ſtanding under the Denomination

nation of Shillings, whereby is to be noted, that 1 Shilling is equal to 12 Pence or 48 Farthings; and likewise that below, that one Penny is equal in Value to four Farthings. Understand the like Reason in all the following Tables of Weight, Measure, Time, Motion and Dozen. (See the Appendix to *Dilworth*'s Arithmetick for the *Irish* Weights and Measures, *&c.*

Of Troy-weight.

3. The least Fraction or Denomination of Weight used in *England*, is a Grain of Wheat gathered out of the Middle of the Ear, and well dried; from whence are produced these following Tables of Weight, called *Troy weight.*

32 Grains of Wheat	make	24 Artificial Grains
24 Artificial Grains	make	1 Penny-weight
20 Penny-weight	make	1 Ounce
12 Ounces	make	1 Pound Troy-weight.

And therefore,

lb	*oz.*	*pwt.*	*gr.*
1	12	20	24
1	12	240	5760
	1	20	480
		1	24

Troy weight serveth only to weigh Bread, Gold, Silver and Electuaries; it also regulateth and prescribeth a Form how to keep the Money of *England* at a certain Standard. But Bread in *Ireland* is now weighed by *Averdupois-weight* and the Ounce is divided into eight Drams.

Of Apothecaries-weight

4. The Apothecaries have their Weights deduced from *Troy-weight*, a Pound *Troy* being the greatest Integer, a Table of whose Division and Subdivision followeth, *viz.*

			And therefore,	lb	*oz.*	*dr.*	*scr.*	*gr.*
1 Pound	make	12 Ounces	1	12	8	3	24
1 Ounce	make	8 Drams	1	12	99	288	5760
1 Dram	make	3 Scruples		1	8	20	480
1 Scruple	make	20 Grains			1	3	60
						1	20

5. Thus much concerning *Troy-weight* and its derivative Weights; besides which, there is another Kind of Weight used in *England*, known by the Name of *Averdupois-weight*, 1 Pound of which is equal to 14 Ounces 12 Penny-weight *Troy-weight*, and it serves to weigh all Kinds of Grocery-wares, and also Butter, Cheese, Flesh, Wax, Tallow, Rosin, Pitch, Lead, *&c.* the Table of Weight is as followeth.

A *Tabl*

A *Table of* Averdupois-weight.

4 Quarters of a Dram	make	1	Dram
16 Drams		1	Ounce
16 Ounces		1	Pound
28 Pounds		1	Quarter of a Hundred
4 Quarters		1	Hundred Wt. or 112lb
20 Hundred		1	Tun

And therefore,

Tun	*C.*	*qrs.*	*lb.*	*oz.*	*drams*	*qrs.*
1	20	4	28	16	16	4
1	20	80	2240	35840	573440	2293760
	1	4	112	1792	28672	114688
		1	28	448	7168	28672
			1	16	256	1024
				1	16	64
					1	4

Wooll is weighed with this Weight, but only the Divisions are not the same.

7 Pounds	make	1	Clove
2 Cloves		1	Stone
2 Stones		1	Todd
6 Todd 1 Stone		1	Wey
2 Weys		1	Sack
2 Sacks		1	Laſt

* In *Ireland*, 16*lb* make a Stone of Wool, to be marked *Wooll*, on the Bags, not Wool.

And therefore,

laſt	*ſack*	*wey*	*todd*	*ſtone*	*cloves*	lb
1	12	2	6½	2	2	7
1	12	24	156	312	624	4368
	1	2	13	26	52	364
		1	6½	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note. That in ſome Counties the Wey is 256lb *Averdupois*, as is the *Suffolk* Wey; but in *Eſſex* there is 336lb to a Wey.

6. The leaſt denomitive Part of Liquid Meaſure is a Pint, which was formerly taken from *Troy-weight*, (1 Pound of Wheat *Troy-weight* making a Pint of Liquid Meaſure) but ſince, by a late Act of Parliament, to prevent Fraud in the Exciſe, the Pint Beer Meaſure is to contain 35¼ ſolid Inches, and the Pint of Wine 28½ the like Inches, *&c.*

A *Table*

A *Table of Liquid Measure.*

35 ¼ Cubical Inches	make	1	Pint Beer Measure
28 ⅞ Cubical Inches		1	Pint Wine Measure
2 Pints		1	Quart
2 Quarts		1	Pottle
†2 Pottles		1	Gallon
8 Gallons		1	Firkin of Ale, Soap or Herrings
9 Gallons		1	Firkin of Beer
10 Gallons and half		1	Firkin of Salmon or Eels
2 Firkins		1	Kilderkin
2 Kilderkins		1	Barrel
42 Gallons		1	Tierce of Wine
63 Gallons		1	Hogshead
2 Hogsheds		1	Pipe or Butt
2 Pipes or Butts		1	Tun of Wine

† The *Irish* Gallon contains 217 $\frac{6}{10}$ cubic Inches, th
Pint 27.2, and 10 Gallons make a Firkin of Ale or Bee
4 Firkins a Barrel, and 8 Barrels a Tun in *Ireland.*

And therefore,

Tuns	*pipes*	*hhd.*	*gal.*	*pint*
	1	2	2	63
1	2	4	252	201
	1	2	126	100
		1	63	50
			1	

7. The leaſt denominative Part of Dry Meaſure is al
a Pint, and this is likewiſe taken from *Troy-weight.*

A *Table of Dry Meaſure.*

1 Pound *Troy*	make	1	Pint
2 Pints		1	Quart
2 Quarts		1	Pottle
2 Pottles		1	Gallon
2 Gallons		1	Peck
4 Pecks		1	Buſhel
4 Buſhels		1	Comb, or *Iriſh* Barre
2 Combs		1	Quarter
4 Quarters		1	Chaldron
5 Quarters		1	Wey
2 Weys		1	Laſt

An

And therefore,

laſt	*wey*	*qrs.*	*combs*	*buſh.*	*pecks*	*gal.*	*pints*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	640	5120
	1	5	10	40	160	320	2560
		1	2	8	32	64	512
			1	4	16	32	256
				1	4	8	64
					1	2	16
						1	8

8. The leaſt denominative Part of Long-meaſure is a Barly-corn well dried, and taken out of the Middle of the Ear, whoſe Table of Parts followeth.

3 Barly-corns	make	1 Inch
12 Inches		1 Foot
3 Feet		1 Yard
3 Feet 9 Inches		1 Ell *Engliſh*
6 Feet		1 Fathom
5 Yards $\frac{1}{2}$ in *England*		
But 7 Yards of *Iriſh* Plantation Meaſure		1 Pole, Perch or Rod
40 Poles or Perches		1 Furlong
8 Furlongs		1 Mile

And therefore,

mile	*furl.*	*poles*	*yards*	*feet*	*inches*	*barly-corns*
1	8	40	$5\frac{1}{2}$	3	12	3
1	8	320	1760	5280	63360	190080
	1	40	220	660	7920	23760
		1	$5\frac{1}{2}$	$16\frac{1}{2}$	198	594
			1	3	36	108
				1	12	36
					1	3

And note, that the Yard, as alſo the Ell, is uſually divided into Quarters, and each Quarter into 4 Nails.

Note alſo, that a geometrical Pace is five Feet, and there are 1056 ſuch Paces in an *Eng.* Mile, 1344 in an *Iriſh.*

9. The Parts of the ſuperficial Meaſures of Land are ſuch as are mentioned in the following Table, *viz.*

A *Table of Land-meaſure.*

40 Square Poles or Perches	make	1 Rood, or Quarter of an Acre
4 Roods		1 Acre

By the foregoing Table of *Long-meaſure* you are informe what a Pole or Perch is; and by this, that 40 ſquare Perche is a Rood: Now a ſquare Perch is a Superficies very aptl reſembled by a ſquare Trencher, every Side thereof being a Perch in Length, 40 of them is a Rood, and 4 Roods a Acre; ſo that a Superficies that is 40 Perches long and broad is an Acre of Land, the Acre containing in all 16 ſquare Perches.

10. The leaſt denominative Part of Time is one Second the greateſt Integer being a Year, from whence is produced this

Table of Time.

60 Seconds	make	1	Minute
60 Minutes		1	Hour
24 Hours		1	Day natural
7 Days		1	Week
4 Weeks		1	Month
13 Months, 1 Day, 6 Hours		1	Year

But the Year is uſually divided into twelve unequal Calender Months, whoſe Names, and the Number of Days they contain, are as follow, *viz.*

	Days		Days
January	31	*July*	31
February	28	*Auguſt*	31
March	31	*Septemb.*	30
April	30	*October*	31
May	31	*Novemb.*	30
June	30	*Decemb.*	31

So that the Year containeth 365 Days, and 6 Hours; but the 6 Hours are not reckoned, but only every Leap Year, and then there is a Day added to the latter End of *February*, and then it containeth 29 Days; and that Year is called Leap-year, and containeth 366 Days.

And here note, that as the Hour is divided into 60 Minutes, ſo each Minute is ſub-divided into 60 Seconds, and each Second into 60 Thirds, and each Third into 60 Fourths, *&c.*

The Tropical Year, by the exacteſt Obſervation of the moſt accurate Aſtronomers, is found to be 365 Days, 5 Hours, 49 Minutes, 4 Seconds and 21 Thirds.

CHAP. III.

Of the Species or Kinds of Arithmetick.

THere are ſeveral Species of this Art, and which may be termed either Natural, Artificial, Analytical Algebraical, Lineal, or Inſtrumental; but what we are now to treat upon relates to the ſingle Parts of Natural Arithmetick, ſo far as concerns Numeration; of which there are alſo four Kinds, *viz. Addition, Subtraction, Multiplication* and *Diviſion.*

CHAP.

CHAP. IV.

Addition of Whole Numbers.

1. *ADDITION* is the Reduction of two or more Numbers, of like Kind, together into one Sum or Total: Or, it is that by which divers Numbers are added together, to the end that the Sum or total Value of them all may be diſcovered.

The firſt Number in every *Addition* is called the *Addible Number*; the other, the *Number* or *Numbers* added; and the *Number* invented by the *Addition* is called the *Aggregate* or *Sum*, containing the Value of the *Addition*.

The Collation of the Numbers, is the right placing the Numbers given reſpectively to each Denomination, and the Operation is the artificial adding of the Numbers given together, in order to the finding out of the Aggragate or Sum.

2. In *Addition* place the Numbers given reſpectively the one above the other, in ſuch ſort, that the like Degree, Place, or Denomination, may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, *&c.*

3. Having thus placed the Numbers given (as before) and drawn a Line under them, add them together, beginning with the leſſer Denomination, *viz.* at the right Hand; and ſo on, ſubſcribing the Sum under the Line reſpectively: As for Example.

Let there be given 3352, and 213, and 133, to be added together. I ſet the Units in each particular Number under each other, and ſo likewiſe the Tens under the Tens, *&c.* and draw a Line under them, as in the Margent; then I begin at the Place of Units and add them together upwards, ſaying, 3 and 3 are 6, and 2 makes 8, which I ſet under the Line, and I under the ſame Figures added together; then I proceed to the next Place being the Place of Tens, and add them in the ſame Manner as I did in the Place of Units, ſaying, 3 and 1 are 4 and 5 are 9, which likewiſe ſet under the Line reſpectively; then I go on to the Place of Hundreds, and add them up as I did the other, ſaying, 1 and 2 are 3 and 3 are 6, which is alſo ſet under the Line; and laſtly, I go to the Place of Thouſands, and becauſe there are no other Figures to add to the 3, I ſet it under the Line

3352
213
133
3698

Line in its reſpective Place, and ſo the Work is finiſhed and I find the Sum of the three given Numbers to be 369

4 But if the Sum of the Figures of any Series exceedeth ten, or any Number of Tens, ſubſcribe under the ſame the Exceſs above the Tens, and for every ten carry one, to be added to the next Series towards the left Hand, and ſo go on till you have finiſhed your Addition, always remembering, that how great ſoever the Sum of the Figures of the laſt Series is, it muſt all be ſet down under the Line reſpectively; ſo 3678 being given to be added to 2357, ſet them down as is before directed, and as you ſee in the Margent, with a Line drawn under them, then I begin and add them together, ſaying, 7 and 8 are 15, which is 5 above 10, wherefore I ſet 5 under the Line, and carry 1 for the 10 to be added to the next, Series, ſaying, 1 that I carried and 5 is 6 and 7 are 13, wherefore I ſet down 3, and carry 1 (for the Ten) to the next Series; then I ſay, 1 that I carried and 3 are 4 and 6 are 10, now, becauſe it comes to juſt 10 and no more, ſet 0 under the Line, and carry 1 for the 10 to the next and ſay, 1 that I carried and 2 are 3 and 3 are 6, which ſet down in its reſpective Place; thus the Addition is ended and the total Sum of theſe Numbers is found to be 603

3678	367
2357	235
6035	603

Several Examples of this Kind follow.

Numbers to be added
354867
573846
785946
347205
Sum 2061864

Numbers to be added
748647
465834
76483
648400
Sum 1939364

Numbers to be added
45346
38074
8437
923
76
Sum 92856

5. If the Numbers given to be added are contained under divers Denominations, as of *Pounds, Shillings, Pence* and *Farthings*, or of *Tuns, Hundreds, Quarters, Pounds &c.* then in this Caſe, having diſpoſed of the Numbers of each Denomination under the others of the like Kind, beginning at the leaſt Denomination (minding how many of one Denomination do make an Integer of the next) and having added them up, for every Integer of the next greater Denomination that you find therein contained, be

an Unit in mind to be added to the ſaid next greater Denomination, expreſſing the Exceſs reſpectively under the Line; proceed in this manner until your Addition be finiſhed; the following Example will make the Rule plain to the Learner. Thus theſe following Sums being given to be added, *viz.* 136*l.* 13*s.* 04*d.* 2*qrs.* and 79*l.* 07*s.* 10*d.* 3*qrs.* and 33*l.* 18*s.* 09*d.* 1*qr.* alſo 15*l.* 09*s.* 05*d.* 0*qrs.* The Numbers being diſpoſed according to Order, will ſtand as in the Margent; then I begin at the Denomination of Farthings, and add them up, ſaying, 1 and 3 are 4 and 2 make 6. Now I conſider that 6 Farthings are 1 Penny 2 Farthings; wherefore I ſet down the 2 Farthings in its Place under the Line, and keep 1 in mind to be added to the next Denomination of Pence; then I go on, ſaying, 1 that I carried and 5 are 6 and 9 are 15 and 10 are 25 and 4 are 29; now I conſider that 29 Pence are 2 Shillings and 5 Pence, therefore I ſet down 5 Pence in Order under the Line, and keep 2 in mind for 2 Shillings to be added to the Shillings: then I go on ſaying, 2 that I carried and 9 are 11 and 18 are 29 and 7 are 36 and 13 are 49; then I conſider that 49 Shillings are 2 Pounds and 9 Shillings, wherefore I ſet the 9 Shillings under the Line, and carry 2 for the 2 Pounds to the next and laſt Denomination of Pounds, and proceed, ſaying, 2 that I carried and 5 make 7 and 3 are 10 and 9 are 19 and 6 are 25; then I ſet down 5 and carry 2 for Tens and proceed, ſaying, 2 that I carry and 1 is 3 and 3 are 6 and 7 are 13 and 3 make 16, and I ſet down 6 and carry 1 for the 10, and go on, ſaying, 1 that I carried and 1 are 2, which I ſet in its Place under the Line, and the Work is finiſhed; and thus I find the Sum of the aforeſaid Numbers to be 265*l.* 9*s.* 5*d.* 2*qrs.*

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2

Here is another Example, in the Operation of which the Learner muſt have an Eye to the Table of *Troy-weight*; the Numbers given are 38 lb. 7 *oz.* 13 *pwt.* 18 *gr.* and 50 lb. 10 *oz.* 10 *pwt.* 12 *gr.* and 42 lb. 8 *oz.* 5 *pwt.* 16 *gr.* and in order to the Addition thereof I place them as you ſee, and proceed to the Operation, ſaying, 16 and 12

are 28 and 18 are 46: now becauſe 24 Grains make 1 Penny-weight, 46 Grains are 1 Penny-weight and 22 Grains, therefore I ſet down 22. and carry 1 for the Penny-weight, and 5 make 6 and 10 are 16 and 13 are 29, which is 1 Ounce and 9 Penny weight; I ſet down 9 in its Place under the Line, and carry 1 to the Ounces, ſaying. 1 that I carry and 8 are 9 and 10 are 19, and 7 are 26, and becauſe 26 Ounces make 2 Pounds 2 Ounces, I ſet down 2 for the Ounces, and carry 2 to the Pounds, going on, 2 that I carry and 2 are 4 and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5 and 5 are 10 and 3 are 13, which I ſet down as in the Margent, and the Work is finiſhed; and I find the Sum of the ſaid Numbers to amount to 132lb 02oz. 9pwt. 22gr. The Way of proving theſe, or any Sum in this Rule, is ſhewed immediately after the enſuing Example.

lb	oz.	pwt.	gr.
38	07	13	18
50	10	10	12
42	08	05	16
132	02	09	22

Addition of Engliſh Money.

l.	s.	d.	q.
436	13	07	1
184	09	10	3
768	17	04	2
584	11	11	0
1974	12	09	2

l.	s.	d.	qrs.
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
168	06	10	1

Addition of Troy-weight.

lb	oz.	pwt.	gr.
15	07	13	12
18	06	04	20
11	10	16	18
09	04	10	22
19	11	18	04
22	00	00	05
97	05	04	09

lb	oz.	pwt.	gr.
145	09	12	18
726	08	14	10
389	07	06	13
83	10	16	20
130	00	10	12
74	07	15	00
1550	08	16	01

Additi

Addition of Apothecaries Weight.

lb	oz.	dr.	sc.	gr.
48	07	1	0	14
74	05	5	2	10
64	10	7	1	16
17	08	1	0	11
34	09	6	1	09
240	05	6	1	00

lb	oz.	dr.	sc.	gr.
60	03	4	0	10
48	10	6	0	14
34	08	2	1	15
18	11	2	2	11
160	07	1	2	15
35	02	5	1	07
358	07	7	0	12

Addition of Averdupois Weight.

Tuns	C.	qrs..	lb
75	13	1	15
48	07	3	21
60	11	1	17
21	07	0	25
12	16	0	11
218	16	0	05

lb	oun.	dr.
36	10	12
22	01	13
11	07	04
15	08	10
20	00	09
105	13	00

Addition of Liquid Measure.

Tuns	pipe	hhd.	gal.
45	1	1	48
15	0	1	17
38	0	0	47
12	1	0	56
21	1	1	18
133	1	1	60

Tuns	hhd.	gal.	pts.
30	3	40	4
12	2	28	6
47	3	60	5
57	3	22	3
17	0	00	0
166	1	26	2

Addition of Dry Measure.

Chal.	qrs.	bush.	pec.
48	3	7	3
13	1	4	0
54	0	6	2
16	3	6	1
40	1	0	1
173	3	0	3

qrs.	bush.	pec.	gal.
17	3	1	1
50	1	3	0
14	5	3	1
40	2	0	1
30	0	3	0
152	5	3	1

Addition of Long Measure.

Yds.	qrs.	nails
35	3	3
14	1	2
74	2	3
38	0	1
30	1	0
15	0	0
208	1	1

Ells	qrs.	nails
56	1	3
13	3	2
48	2	1
50	0	2
74	2	0
17	1	0
260	1	0

Addition of Land Measure.

Acre	*Rood*	*Perch*	*Acre*	*Rood*	*Perch*
12	3	18	86	1	36
14	0	24	47	3	24
30	2	19	73	2	28
48	3	30	60	0	07
28	1	38	04	2	08
50	3	26	14	1	14
185	3	35	286	3	37

The Proof of Addition.

6. *Addition* is proved after this Manner: When you have found out the Sum of the Numbers given, then separate the uppermost Line from the rest, with a stroke or Dash of the Pen, and then add them all up again as you did before, leaving out the uppermost Line; and having done, add the new invented Sum to the uppermost Line you separated, and if the Sum of these two Lines be equal to the Sum first found out, then the Work is performed true, otherwise not. As for Example: Let us prove the first Example of *Addition of Money*, whose Sum we found to be 265*l.* 9*s.* 5*d.* 2*qrs.* and which we prove thus: Having separated the uppermost Number from the rest by a Line, as you see in the Margent, then I add the same together again, leaving out the said uppermost Line, and the Sum thereof I set under the first Sum or true Sum, which doth amount to 128*l.* 16*s.* 1*d.* 0*qrs.* then again I add the new Sum to the uppermost Line, that before was separated from the rest, and the Sum of these two is 265*l.* 09*s.* 5*d.* 2*qrs.* the same with the first Sum, and therefore I conclude that the Operation was rightly performed.

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	01	0
265	09	05	2

7. The main End of *Addition*, in Questions resolvable thereby, is to know the Sum of several Debts, Parcels, Integers, *&c.* Some Questions may be these that follow.

Quest. 1. There was an old Man whose Age was required; to which he replied, I have seven Sons, each having two Years between their Birth, and in the 44th Year of my Age my eldest Son was born, which is now the Age of the youngest. I demand what was the old Man's Age.

Now to resolve this Question, first set down the Father's Age at the Birth of his first Child, which was 44; the

he Difference between the oldeſt and the youngeſt, which is 12 Years, and then the Age of the youngeſt, which is 44; and then add them all together, and their Sum is 100, the compleat Age of their Father.

	44
	12
	44
	100

Queſt. 2. A Man lent his Friend, at ſeveral Times, theſe ſeveral Sums, *viz.* at one Time 63*l.* at another Time 50*l.* at another Time 48*l.* at another Time 156*l.* Now I deſire to know how much was lent him in all?

Set the Sums lent under one another, as you ſee in the Margent, and then add them together, and you will find their Sum to amount to 317*l.* which is the Total of all the ſeveral Sums lent, and ſo much is due to the Creditor.

	63
	50
	48
	156
	317

Queſt. 3. There are two Numbers, the leaſt whereof is 40, and their Difference 14. I deſire to know what is the greater Number, and alſo what is the Sum of them both? Firſt ſet down the leaſt, *viz.* 40, and 14 the Difference, and add them together, and their Sum is 54 for the greateſt Number; then I ſet 40 (the leaſt) under 54 (the greateſt) and add them together, and their Sum is 94, equal to the greateſt and leaſt Numbers.

	40
	14
greateſt	54
leaſt	40
Sum	94

CHAP. V.

Of Subtraction *of Whole Numbers.*

SUBTRACTION, is the taking a leſſer Number out of a greater of a like Kind, whereby to find out a third Number, being or declaring the Inequality, Exceſs, or Difference between the Numbers given; or, *Subtraction* is that by which one Number is taken out of another Number given, to the End that the Reſidue or Remainder may be known, which Remainder is alſo called the Reſt, Remainder, or Difference of the Numbers given.

2. The Number out of which *Subtraction* is to be made muſt be greater, or at leaſt equal with the other Number given; the higher Number is called the *Major*, and the lower, *Minor*; and the Operation of *Subtraction* being finiſhed, the Reſt or Remainder is called the *Difference* of the Number given.

3. In *Subtraction*, place the Numbers given reſpectively the one under the other, in ſuch Sort as like Degrees, Places, or Denominations may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Pounds under Pounds,

Pounds, &c. Feet under Feet, and Parts under Parts, &c. This being done, draw a Line underneath, as in *Addition*.

4. Having placed the Numbers given as is before directed, and drawn a Line under them, ſubtract the lower Number (which in this Caſe muſt always be leſs than the uppermoſt) out of the higher Number, and ſubſcribe the Difference or Remainder reſpectively below the Line, and when the Work is finiſhed, the Number below the Line will give you the Remainder.

As for Example: Let 364521 be given to be ſubtracted from 795836, I ſet the leſſer under the greater, as in the Margent, and draw a Line under them; then

795836
364521

431315

beginning at the Right Hand, I ſay, 1 out of 6 and there remains 5, which I ſet in order under the Line; then I proceed to the next, ſaying, 2 from 3 reſts 1, which I note alſo under the Line; and thus I go on till I have finiſhed the Work, and then I find the Remainder or Difference to be 431315.

5. But if it ſo happen (as commonly it doth) that the lowermoſt Number or Figure is greater than the uppermoſt: then in this Caſe add ten to the uppermoſt Number, and ſubtract the ſaid lowermoſt Number from their Sum, and the Remainder place under the Line; and when you go to the next Figure below pay an Unit, by adding it thereto, for the ten you borrowed before, and ſubtract that from the higher Number of Figures, and thus go on till your Subtraction be finiſhed. As for Example: Let 437503 be given, from whence it is required to ſubtract 153827, I diſpoſe of the Numbers as is before directed, and as you ſee in the Margent; then I begin, ſaying,

437503
153827

283676

7 from 3 I cannot, but (adding 10 thereto) I ſay 7 from 13 and there remains 6, which I ſet under the Line in Order; then I proceed to the next Figure, ſaying, 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remains 7, which I likewiſe ſet down as before; then 1 that I borrowed and 8 is 9 from 5 I cannot, but 9 from 15 and there remains 6; then 1 I borrowed and 3 is 4 from 7 and there remains 3; then 5 from 3 I cannot, but 5 from 13 and there remains 8; then 1 I borrowed and 1 are 2 from 4 and there reſt 2, and thus the Work is finiſh'd: After theſe Numbers are ſubtracted one from another, the Inequality, Remainder, Exceſs or difference is found to be 283676. Examples for thy farther Experience may be theſe that follow.

From 3469916	From 361577
Take 738642	Take 5864
Reſt 2731274	Reſt 355713

6. I

6. If the Sum or Number to be ſubtracted is of ſeveral Denominations, place the leſſer Sum below the greater, and in the ſame Rank and Order as is ſhewed in *Addition* of the ſame Numbers; then begin at the right Hand, and take the lower Number out of the uppermoſt, if it be leſſer; but if it be greater than the uppermoſt, then borrow an Unit from the next greater Denomination, and turn it into the Parts of the leſſer Denomination, and add thoſe Parts to the uppermoſt, noting the Remainder below the Line; then proceed and pay one to the next Denomination for that which you borrowed before; and proceed in this Order till the Work is finiſhed. An Example of this Rule followeth: Let 375*l.* 13*s.* 7*d.* 1*qr.* be given, from whence let it be required to ſubtract 57*l.* 16*s.* 3*d.* 2*qrs.* In order whereunto I place the Numbers as you ſee in the Margent; and thus I begin at the leaſt Denomination, ſaying, 2 from 1 I cannot, therefore I borrow one Penny from the next Denomination, and turn it into Farthings, which is 4, and adding 4 to 1, which is 5, I ſay, but 2 from 5 and there remains 3, which I put under the Line; then going on I ſay, 1 that I borrowed and 3 is 4 from 7 and there reſts 3; then going on I ſay, 16 from 13 I cannot, but borrowing 1 Pound, and turning it into 20 Shillings, I add it to 13, and that is (33) wherefore I ſay, 16 from 33 and there remains 17, which I ſet under the Line, and go on, ſaying, 1 that I borrowed and 7 is 8 from 5 I cannot, but 8 from 15 and there remains 7, and the 1 that I borrowed and 5 is 6 from 7 there reſts 1, and 0 from 3 reſts 3, and the Work done: And I find the Remainder or Difference to be 317*l.* 17*s.* 3*d.* 3*qrs.*

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3

Another Example of *Troy-weight* may be this, I would ſubtract 17 *lb* 10*oz.* 11*pwt.* 20*gr.* from 24*lb* 5*oz.* 00*pwt.* 08*gr.* I place the Numbers according to the Rule, and begin ſaying, 20 from 8 I cannot, but I borrow 1 Penny-weight, which is 24 Grains and add them to 8, and theſe are 32, wherefore I ſay 20 from 32 reſts 12; then 1 that I borrowed and 11 is 12 from 00 I cannot, but 12 from 20 (borrowing an Ounce, which is 20 Penny weight) and there remains 8;

lb	*oz.*	*pwt.*	*gr.*
24	05	00	08
17	10	11	20
06	06	08	12

then 1 that I borrowed and 10 is 11 from 5 I cannot, but 1 from 17 and there reſts 6; then 1 that I borrowed and 7 is 8 from 4 I cannot, but 8 from 14 and there reſts 6; then 1 that I borrowed and 1 is 2 from 2 and there reſts nothing; ſo that I find the Remainder or Difference to be 6*lb* 6*oz.* 8*pwt.* 12*gr.*

7. If many times happeneth that you have many Sums or Numbers to be ſubtracted from one Number; as, ſuppoſe a Man ſhould lend his Friend a certain Sum of Money, and his Friend hath paid him part of his Debt at ſeveral Times, then before you can conveniently know what is ſtill owing, you are to add the ſeveral Number or Sums of Payment together, and ſubtract their Sum from the whole Debt, and the Remainder is the Sum due to the Creditor: As ſuppoſe *A* lendeth to *B* 564*l.* 16*s.* 10*d.* and *B* hath repaid him 79*l.* 16*s.* 8*d.* at one Time, and 163*l.* 18*s.* 11*d.* at another Time, and 241*l.* 15*s.* 8*d.* another Time; and you would know how the Account ſtandeth between them, or what is more due to *A*. In order whereunto I firſt ſet down the Sum which *A* lent, and draw a Line underneath it, then under that Line I ſet the ſeveral Sums of Payment, as you ſee in the Margent; and having brought the ſeveral Sums of Payment into one Total, by the 5th Rule of the 4th Chapter foregoing, I find their Sum amounteth to 485*l.* 11*s.* 3*d.* which I ſubtract from the Sum firſt lent by *A*, by the 6th Rule of this Chapter, and I find the Remainder to be 79*l.* 5*s.* 7*d.* and ſo much is ſtill due to *A*.

	l.	*s.*	*d.*
Lent	564	16	10
Paid at ſeveral Payments.	79	16	08
	163	18	11
	241	15	08
Paid in all	485	11	03
Remains	79	05	07

When the Learner hath good Knowledge of what hath been already delivered in this and the foregoing Chapters, he will with Eaſe underſtand the Manner of working the following Examples.

Subtraction of Whole Numbers.

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	374	10	03	700	10	11	2
Paid	79	15	11	9	03	11	3
Remains	294	14	04	691	06	11	3
	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	1000	00	00	711	03	00	0
Paid	19	00	06	11	13	00	1
Remains	980	19	06	699	09	11	3

Borrowe

	l.	*s.*	*d.*	*qrs.*
Borrowed	3500	00	00	0
Paid at ſeveral Payments	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remains due	2304	07	09	1

Subtraction of Troy-weight.

	lb	*oz.*	*pwt.*	*gr.*
Bought	174	00	13	00
Sold	78	04	16	15
Remains	95	07	16	09

	lb	*oz.*	*pwt.*	*gr.*
Bought	470	10	13	00
	60	00	00	00
Sold at ſeveral Times	35	10	18	00
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Remain unſold	225	00	05	17

Subtraction of Apothecaries Weight.

	lb	*oz.*	*dr.*	*ſc.*	*gr.*	lb	*oz.*	*dr.*	*ſc.*	*gr.*
Bought	12	04	3	0	00	20	00	1	0	07
Sold	8	05	1	1	15	10	00	1	2	12
Rem.	3	11	1	1	05	9	11	7	0	15

Subtraction of Averdupois-weight

	C.	*qrs.*	lb	*Tun*	*C.*	*qrs.*	lb	*oz.*	*dr.*
Bought	35	0	15	5	07	1	10	10	05
Sold	16	2	20	3	17	1	16	09	13
Remain	18	1	23	1	09	3	22	00	08

Subtraction of Liquid Meaſure.

	tu.	*hhd.*	*gal.*	*tu.*	*hhd.*	*gal.*	*pints*
Bought	40	1	30	60	3	42	4
Sold	16	1	40	15	3	46	6
Remain	23	3	53	44	3	58	6

Subtraction of Dry Measure.

	chal. qrs. buſh. pec.	*cha. qrs. buſh. pecks*
Bought	100 0 0 0	73 2 3 2
Sold	54 1 4 3	46 2 3 3
Remain	45 2 3 1	26 3 7 3

Subtraction of Long Meaſure.

	yds. qrs. nails	*yds. qrs. nails*
Bought	160 0 0	344 0 1
Sold	64 1 2	177 1 3
Remain	95 2 2	166 2 2

Subtraction of Land Meaſure.

	acres rood perch.	*acres rood perches*
Bought	140 2 13	600 0 00
Sold	70 3 12	54 0 16
Remain	69 3 01	545 3 24

The Proof of Subtraction.

8. When your Subtraction is ended, if you deſire to prove the Work, whether it be true or not, then add the Remainder to the *minor* Number, and if the Aggregate of theſe two be equal to the *major* Number, then is your Operation true, otherwiſe falſe: Thus let us prove the firſt Example of the fifth Rule of this Chapter, where, after Subtraction is ended, the Numbers ſtand as in the Margent, the Remainder or Difference being 283676: Now to prove the Work, I add the ſaid Remainder 283676 to the *minor* Number 153827, by the fourth Rule of the foregoing Chapter, and I find the Sum or Aggregate to be 437503, equal to the *major* Number, or Number from whence the leſſer is ſubtracted. See the Work in the Margent.

437503
153827
283676
437503

The Proof of another Example, may be of the firſt Example of the 6th Rule of this Chapter, where it is required, to ſubtract 57*l.* 16*s.* 3*d.* 2*qrs.* from 375*l.* 13*s.* 7*d.* 1*qr.* and by the Rule I find the Remainder to be 317*l.* 17*s.* 3*d.* 3*qrs.* Now to prove it, I add the ſaid Remainder 317*l.* 17*s.* 3*d.* 3*qrs.* to the *minor* Number 57*l.* 16*s.* 3*d.* 2*qrs.* and their Sum is 375*l.* 13*s.* 7*d.* 1*qr.* equal to the *major* Number which proves the Work to be true; but if it had happened to be either more or leſs than the ſaid *major* Number, then the Operation hath been falſe.

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3
375	13	07	1

9. The

Borrow

9. The general Effect of Subtraction, is, to find the Difference or Exceſs between two Numbers, and the Reſt when a Payment is made in part of a greater Sum, the Date of Books printed, the Age of any Thing, by knowing the preſent Year, and the Year wherein they were made, created, or built, and ſuch like.

The Queſtions appropriated to this Rule are ſuch as follow.

Queſt. 1. What difference is there between one Thing of 125 Foot long, and another of 66 Foot long?

To reſolve this Queſtion, I firſt ſet down the *major* or greater Number 125, and under it the *minor* or leſſer Number 66, as is directed in the third Rule of this Chapter, and according to the fourth Rule of the ſame, I ſubtract the *minor* from the *major*, and the Remainder, Exceſs, or Difference I find to be 59. See the Work in the Margent.

125
66
59

Queſt. 2. A Gentleman having owed a Merchant 365*l.* whereof he hath paid 278*l.* What more doth he owe?

To give an Anſwer to this Queſtion, I firſt ſet down the *major* Number 365*l.* and under it I place 278 the *minor*, and ſubtract the one from the other, whereby I diſcover the Exceſs, Difference or Remainder to be 87; and ſo much is ſtill due to the Creditor, as *per* Margent.

365
278
87

Queſt. 3. An Obligation was written, a Book printed, a Child born, a Church built, or any other Thing made in the Year of our Lord 1572, and now we account the Year of our Lord 1756, the Queſtion is, to know the Age of the ſaid Things, that is, how many Years are paſſed ſince the ſaid Things were made? I ſay, if you ſubtract the leſſer Number 1572, from the greater 1756, the Remainder will be 184, and ſo many Years are paſſed ſince the making of the ſaid Things; as by this Work in the Margent.

1756
1572
184

Queſt. 4. There are three Towns lying in a ſtraight Line, *viz. London*, *Huntingdon* and *York*, now the Diſtance between the fartheſt of theſe Towns, *viz. London* and *York*, is 151 Miles, and from *London* to *Huntingdon* is 49 Miles, I demand how far is it from *Huntingdon* to *York*?

To reſolve this Queſtion, ſubtract 49 the Diſtance between *London* and *Huntingdon*, from 151, the Diſtance between *London* and *York*, and the Remainder is 102, for the true Diſtance between *Huntingdon* and *York*. See the Work in the Margent.

151
49
102

CHAP.

CHAP. VI.

Multiplication of Whole Numbers.

1. MULTIPLICATION is performed by two Numbers of like Kind, for the Production of a third, which ſhall have Reaſon to the one as the other hath to the Unit, and in Effect is a moſt brief and artificial *Compound Addition* of many equal Numbers of like Kind into one Sum. Or, *Multiplication* is that by which we multiply two or more Numbers, the one into the other, to the end that their Product may come forth, or be diſcovered.

Or, Multiplication is the increaſing of any one Number by any other, ſo often as there are Units in that Number, by which the other is increaſed; or by having two Numbers given, to find a third which ſhall contain one of the Numbers as many Times as there are Units in the other.

2. *Multiplication* hath three Parts. Firſt, the Multiplicand, or Numbers to be multiplied. Secondly, the Multiplier, or Number given, by which the Multiplicand is to be multiplied. And Thirdly, the Product, or Number produced by the other two, the one being multiplied by the other; as if 8 were given to be multiplied by 4, I ſay 4 times 8 is 32; here 8 is the Multiplicand, and 4 is the Multiplier, and 32 is the Product.

8
4
—
32

3. *Multiplication* is either *Single*, by one Figure; or *Compound*, that conſiſts of many.

Single Multiplication is ſaid to conſiſt of one Figure, becauſe the Multiplicand and Multiplier conſiſt each of 'em of a Digit, and no more; ſo that the greateſt Product that can ariſe by *Single Multiplication* is 81, being the Square of 9; and *Compound Multiplication* is ſaid to conſiſt of many Figures, becauſe the Multiplicand or Multiplier conſiſts of more Places than one; as if I were to multiply 436 by 6: It is called *Compound*, becauſe the Multiplicand 436 is of more Places than one, *viz.* 3 Places.

4. The Learner ought to have all the Varieties of *Single Multiplication* by Heart, before he can well proceed any farther into this Art, it being of moſt excellent Uſe, and none of the following Rules in *Arithmetick* but what have a principal Dependance thereupon.

MULTIPLICATION TABLE.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	15	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The Use of the precedent Table is this: In the uppermost Line or Column you have expressed all the Digits from 1 to 9, and likewise beginning at 1 and going downwards in the Side Column, you have the same; so that if you would know the Product of any two single Numbers multiplied by one another, look for one of them (which you please) in the uppermost Column, and for the other in the side Column, and running your Eye from each Figure along their respective Columns in the common Angle (or Place) where these two Columns meet, there is the Product required. As for Example, I would know how much is 8 times 7; first, I look for 8 in the uppermost Column, and 7 in the side Column; then do I cast my Eye from 8 along the Column downwards from the same, and likewise from 7 in the side Column, I cast my Eye from thence toward the right Hand, and find it to meet with the first Column at 56, so that I conclude 56 to be the Product required, *&c.*

5. In *Compound Multiplication*, if the Multiplicand consists of many Places, and the Multiplier of but one Figure, first set down the Multiplicand, and under it place the Multiplier in the place of Units, and draw a Line underneath them; begin then and multiply the Multiplier into every particular Figure of the Multiplicand, beginning at the Place of Units, and so proceed towards the left Hand, setting each particular Product under the Line, in order as you proceed; but if any of the Products exceed 10, or any Number of Tens, set down the Excess, and for every 10 carry an Unit to be added to the next Product, always remembring to set down the total Product of the last Figure; which Work being finished, the Sum or Number placed under the Line shall be the true and total Product required.

As

As for Example, I would multiply 478 by 6; first set down 478, and underneath it 6, in the place of Units, and draw a Line underneath them, as in the Margent, then I begin, saying 6 times 8 is 48, which is 8 above four Tens, therefore I set down 8 (the Excess) and bear 4 in mind for the 4 Tens; then I proceed, saying, 6 times 7 is 42, and 4 that I carried is 46, I then set down 6 and carry 4, and go on, saying, 6 times 4 is 24, and 4 that I carried is 28, and because it is the last Figure I set it all down, and so the Work is finished, and the Product is found to be 2868, as was required.

```
 478
   6
 ----
2868
```

6. When in *Compound Multiplication* the Multiplier consisteth of divers Places, then begin with the Figure in the Place of Units in the Multiplier, and multiply it into all the Figures in the Multiplicand, placing the Product below the Line, as was directed in the last Example; then begin with the Figure of the second Place of the Multiplier, *viz.* the Place of Tens, and multiply it likewise into the whole Multiplicand (as you did the first Figure) placing its Product under the Product of the first Figure; do in the same manner by the third, fourth and fifth, *&c.* until you have multiplied all the Figures of the Multiplier particularly into the whole Multiplicand, still placing the Product of each particular Figure under the Product of its precedent Figure; herein observing the following Caution.

A Caution. In the placing of the Product of each particular Figure of the Multiplier, you are not to follow the 2d Rule of the 4th Chapter, *viz.* to place Units under Units, and Tens under Tens, *&c.* but to place the Figure or Cypher in the place of Units of the second Line under the second Figure or Place of Tens in the Line above it, and the Figure or Cypher in the Place of Units in the third Line under the place of Tens in the second Line, *&c.* observing this Order till you have finished the Work, still placing the first Figure of every Line or Product under the second Figure or Place of Tens in that which was above it, and having so done, draw a Line under all these particular Products and add them together; so shall the Sum of all these Products be the total Product required.

As if it were required to multiply 764 by 27, I set 'em down the one under the other, with a Line drawn underneath them, then I begin, saying, 7 times 4 is 28, then I set down 8 and carry 2; then I say, 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4; then 7 times 7 is 49, and 4 that I carry is 53, which I set down because I have not another

```
  764
   27
 ----
 5348
1528
20628
```

nother Figure to multiply; thus have I done with the 7; hen I begin with the 2, saying, 2 times 4 is 8, which I set down under (4) the second Figure or place of Tens in the Line above it, as you may see in the Margent; then I proceed, saying, 2 times 6 is 12, that is 2 and carry 1, then 2 times 7 is 14, and 1 that I carry is 15, which I set down, because it is the Product of the last Figure, so that the Product of 764 by 7 is 5348, and by 2 is 1528, which being placed the one under the other, as before directed, as you see in the Margent, and a Line drawn under them, and they added together respectively make 20628, the true Product required, being equal to 27 times 764.

Another Example may be this: Let it be required to multiply 5486 by 465, I dispose of the Multiplicand and Multiplier according to the Rule, and begin multiplying the first Figure of the Multiplier, which is (5) into the whole Multiplicand, and find the Product is 27430; then I proceed, and multiply the second Figure (6) of the Multiplier into the Multiplicand, and find the Product to amount to 32916, which is subscribed under the other Product respectively; then do I multiply the third and last Figure (4) of the Multiplier into the Multiplicand, and the Product is 21944, which is likewise placed under the second Line respectively; then I draw a Line under the said Product, being placed the one under the other (according to Rule) and add them together, and the Sum is 2550990, the true Product sought, being equal to 5486 times 465, or 465 times 5486.

5486	
465	
27430	
32916	
21944	
2550990	

More Examples in this Rule are these following.

430865	6400758
4739	37496
3877785	38404548
1292595	57606822
3016055	25603032
1723460	44805306
2041869235	19202274
	240002821968

Compendium in Multiplication.

7. Altho' the former Rules are sufficient for all Cases in *Multiplication*, yet because in the Work of *Multiplication* many times great Labour may be saved, I shall acquaint the

the Learner with ſome Compendiums in order thereto *viz.* if the Multiplicand or Multiplier, or both of them end with Cyphers, then in your multiplying you may neglect the Cyphers, and multiply only the ſignificant Figures, and to the Product of theſe ſignificant Figures add ſo many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the right Hand of the ſaid Product, ſo ſhall that give you the true Product required. As if I were to multiply 32000 by 4300, I ſet them down in order to be multiplied, as you ſee in the Margent, but neglecting the Cyphers in both Numbers, I only multiply 32 by 43, and the Product I find to be 1376, to which I annex the 5 Cyphers in the Multiplicand and Multiplier, and then it makes 137600000 for the true Product of 32000 by 4300.

Si numeris propoſitis unus vel uterque adjunctos habeat ad dextram circulos, omiſſis circulis fiat ipſorum numerorum multiplicatio, & facta demum tot inſuper integrorum loci accenſeantur quot ſunt omiſſi circuli in utraque factore. Clavis Mat. *c.* 4. 3.

32000
4300
96
128
137600000

8. If in the Multiplier, Cyphers are placed between ſignificant Figures, then multiply only by the ſignificant Figures neglecting the Cyphers; but here ſpecial Notice is to be taken of the true placing of the firſt Figure after the Neglect of ſuch Cypher or Cyphers, and therefore you muſt obſerve in what Place of the Multiplier the Figure you multiply by ſtandeth, and ſet the firſt Figure of that Product under the ſame Place of the Product of the firſt Figure of your Multiplier: As for Example, let it be required to multiply 371568 by 40007; firſt I multiply the Multiplicand by 7, and the Product is 2600976; then, neglecting the Cyphers, I multiply by 4, and that Product is 1486272; now I conſider that 4 is the fifth Figure in the Multiplier, therefore I place 2 (the firſt Figure of the Product by 4) under the fifth place of the firſt Product by 7, and the reſt in Order, and having added them together, the total Product is found to be 14865320976. Other Examples in this Rule are theſe following.

Si intermedio multiplicantis loco circulus fuerit, ille negligitur. Alſted. *c.* 6. *de Arith.*

371568
40007
2600976
1486272....
14865320976

32758

327586	7864371
6030	20604
9827580	31457484
1965516	47186226
1975343580	15728742
	162037500084

9. If you are to multiply any Number by an Unit with Cyphers, as by 10, 100, 1000, *&c.* then annex so many Cyphers before the Multiplicand, and that Number when the Cyphers are annexed is the Product required. As if you would multiply 428 by 100, annex two Cyphers to 428 and it is 42800. If it were required to multiply 102 by 10000, annex 4 Cyphers, and it gives 1020000 for the Product required.

The Proof of Multiplication.

10. *Multiplication* is proved by *Division*, and to speak Truth, all other Ways are false (according to *Frisius*) and therefore it will be necessary in the first place to learn *Division*, and by that to prove *Multiplication*. There are some other Ways used indeed, but on a strict *Examen*, there is not one in a thousand of their Products right; therefore we omit them.

11. The general Effect of *Multiplication* is contained in the Definition of the same, which is to find out a third Number, so often containing one of the two given Numbers as the other containeth Units.

The second Effect is, by having the Length and Breadth of any Thing (as a Parallelogram or long Plain) to find the superficial Content of the same; and by having the superficial Content of the Base, and the Length, to find out the Solidity of any Parallelopipedon, Cylinder, or other solid Figure.

The Third Effect is, by the Contents, Price, Value, buying, selling, Expence, Wages, Exchange, Simple Interest, Gain or Loss of any one Thing, be it Money, Merchandize, *&c.* to find out the Value, Price, Expence, buying, selling, Exchange, or Interest, of any Number of Things of the like Name, Nature and Kind.

The fourth Effect is not much unlike the other, by the Contents, Value or Price of any one Part of any Thing denominated, to find the Contents, Value or Price of the whole Thing, all the Parts into which the Whole is divided, multiplying the Price of one of those Parts.

The fifth Effect is, to aid, to compound and to make other Rules, as chiefly, the *Rule of Proportion*, called the *Golden Rule*, or *Rule of Three*; also by it Things of one Denomination are reduced to another.

If

If you multiply any Number of Integers, by the Price of the Integer, the Product will discover the Price of the Quantity, or Number of Integers given.

In a rectangular Solid, if you multiply the Breadth of the Base by the Depth, and that Product by the Length, the last Product will discover the Solidity or Content of the same Solid.

Some Questions proper to this Rule, may be these following.

Quest. 1. What is the Content of a square Piece of Ground, whose Length is 28 Perches and Breadth 13?

Answer, 364 square Perches; for multiplying 28 the Length, by 13 the Breadth, the Product is so much.

Quest. 2. There is a square Battle, whose Flank is 47 Men, and the Files 19 deep, what Number of Men doth that Battle contain? *Facit* 893; for multiplying 47 by 19 the Product is 893.

Quest. 3. If any one Thing cost 4 Shillings, what shall 9 such Things cost? *Answ.* 36 Shillings; for multiplying 4 by 9 the Product is 36.

Quest. 4. If a Piece of Money or Merchandize be worth or cost 17 Shillings, what shall 19 such Pieces of Money or Merchandize cost? *Facit* 323 Shillings, which is equal to 16*l*, 3*s*.

Quest. 5. If a Soldier or Servant get or spend 14*s*. *per* Month, what is the Wages or Charges of 49 Soldiers or Servants for the same Time? Multiply 49 by 14, the Product is 686*s*. or 34*l*. 6*s*. for the Answer.

Quest 6. If in a Day there are 24 Hours, how many Hours are there in a Year, accounting 365 Days to constitute the Year? *Facit* 8760 Hours, to which if you add the 6 Hours over and above 365 Days, as there is in a Year, then it will be 8766 Hours; now if you multiply this 8766 by 60, the Number of Minutes in an Hour, it will produce 525960, the Number of Minutes in a Year.

CHAP. VII.

Division of Whole Numbers.

1. DIVISION is the separating or parting of any Number or Quantity given, into any Part assigned; or to find how often one Number is contained in another; or from any two Numbers given, to find a third that shall consist of so many Units, as the one of those two Numbers given is comprehended, or is contained in the other.

2. *Division* hath three Parts of Numbers remarkable, *viz. first*, the Dividend; 2*dly*, the Divisor, 3*dly*, the Quotient.

tient. The Dividend is the Number given to be parted or divided. The Diviſor is the Number given by which the Dividend is divided, or it is the Number which ſheweth how many Parts the Dividend is to be divided into, and the Quotient is the Number produced by the Diviſion of the two given Numbers the one by the other.

So 12 being given to be divided by 3, or into three equal Parts, the Quotient will be 4; for 3 is contained in 12 four times, where 12 is the Dividend, and 3 is the Diviſor, and 4 is the Quotient

3. In *Diviſion*, ſet down your Dividend, and draw a crooked Line at each End of it, and before the Line at the left Hand place the Diviſor, and behind that on the right Hand place the Figures of the Quotient, as in the Margent, where it is required to divide 12 by 3; first, I ſet down 12 the Dividend, and on each Side of it I draw a crooked Line, and before that on the left Hand do I place 3 the Diviſor, then do I ſeek how often 3 is contained in 12, and becauſe I find it four times, I put 4 behind the crooked Line, on the right Hand of the Dividend, denoting the Quotient.

3)12(4

4. But if, when the Diviſor is a ſingle Figure, the Dividend conſiſteth of two or more Places, then having placed them for the Work (as before directed) put a Point under the firſt Figure of the left Hand of the Dividend, provided it be bigger than (or equal to) the Diviſor; but if it be leſſer than the Diviſor, then put a Point under the ſecond Figure from the left Hand of the Dividend, which Figures, as far as the Point goeth from the left Hand, are to be reckon'd by themſelves, as if they had no Dependence upon the other part of the Dividend, and for Diſtinction ſake may be called the Dividual; then ask how often the Diviſor is contained in the Dividual, placing the Anſwer in the Quotient, then multiply the Diviſor by the Figure that you placed in the Quotient, and ſet the Product thereof under your Dividual, then draw a Line under the Product, and ſubtract the ſaid Product from the Dividual, placing the Remainder under the ſaid Line; then put a Point under the next Figure in the Dividend, on the right Hand of that to which you put the Point before, and draw it down, placing it on the right Hand of the Remainder which you found by *Subtraction*, which Remainder, with the ſaid Figure annexed before it, ſhall be a new Dividual; then ſeek again how often the Diviſor is contained in this new Dividual, and put the Anſwer in the Quotient, on the right Hand of the Figure which you put there before; then multiply the Diviſor by the laſt Figure that you put in the Quotient, and ſubſcribe the

the Product under the Dividual and make Subtraction, and to the Remainder draw down the next Figure from the grand Dividend (having first put a Point under it) and put it on the right Hand of the Remainder for a new Dividual, as before: and proceed thus till the Work is finished.

Observing this general Rule in all Kinds of *Division*; first, to seek how often the Divisor is contained in the Dividual, then (having put the Answer in the Quotient) multiply the Divisor thereby, and subtract the Product from the Dividual: An Example or two will make the Rule Plain. Let it be required to divide 2184 by 6. I dispose of the Numbers given as is before directed, and as you see in the Margent; in order to the Work, then because 6 the Divisor is more than 2 the first Figure of the Dividend, I put a Point under 1 the second Figure, which makes 21 for the Dividual; then do I ask how often 6 the Divisor is contained in 21, and because I cannot have it more than 3 times, I put 3 in the Quotient, and thereby do I multiply the Divisor (6) and the Product is 18, which I set in order under the Dividual, and subtract it therefrom, and the Remainder (3) I place in order under the Line, as you see in the Margent.

```
6) 2184 (3
```

```
6) 2184 (3
   18
   ---
    3
```

```
6) 2184 (36
   18
   ---
   38
   36
   ---
    2
```

Then do I make a Point under the next Figure of the Dividend, being 8, and draw it down, placing it before the Remainder 3, so have I 38 for a new Dividual; then do I seek how often 6 is contained in 38, and because I can't have it more than 6 times, I put 6 in the Quotient, and thereby do I multiply the Divisor 6, and the Product (36) I put under the Dividual (38) and subtract it therefrom, and the Remainder (2) I put under the Line, as you see in the Margent.

Then do I put a Point under the next (and last) Figure of the Dividend (being 4) and draw it down to the Remainder 2, and putting it on the right Hand thereof, it maketh 24 for a new Dividual; then I ask how often 6 is contained in 24, and the Answer is 4, which I put into the Quotient, and multiply the Divisor (6) thereby, and the Product (24) I put under the Dividual (24) and subtract it therefrom, and the Remainder is (0); and thus the Work is finished, and I find the Quotient to be 364, that is, 6 is contained in 2184 just 364 times, or 2184 being divided into 6 equal Parts, 364 is one of those Parts.

```
6) 2184 (364
   18
   ---
   38
   36
   ---
   24
   24
   ---
   (0)
```

Again,

Again, if it were required to divide 2646 by 7, or into 7 equal Parts, the Quotient will be found to be 378, as by the following Operation appeareth.

```
7) 2646 (378
...
  21
  ---
   54
   49
   --
    56
    56
    --
    00
```

So if it be required to divide 964 by 8, the Quotient will be found to be 118, and 2 remaining after Division is ended. The Work followeth:

```
8) 946 (118
...
  8
  --
   14
    8
    --
    66
    64
    --
    (2)
```

Many times the Dividend cannot exactly be divided by the Divisor, but something will remain, as in the last Example, where 946 was given to be divided by 8, the Quotient was 118, and there remained 2 after the Division was ended: Now what is to be done in this Case with the Remainder, the Learner shall be taught when we come to treat of the reducing (or Reduction) of Fractions.

And here note, That if, after your Division is ended, any Thing do remain, it must be lesser than your Divisor, for otherwise your Work is not rightly performed.

Other Examples are such as follow.

```
8) 73464 (9183
....
  72
  --
   14
    8
    --
    66
    64
    --
    24
    24
    --
    (0)
```

```
9) 13758 (1528
....
  9
  --
   47
   45
   --
    25
    18
    --
    78
    72
    --
    (6)
```

But

5. But if the Diviſor conſiſteth of more Places than one, then chuſe ſo many Figures from the left Side of the Dividend for a Dividual as there are Figures in the Diviſor, and put a Point under the fartheſt Figure of that Dividual to the right Hand, and ſeek how often the firſt Figure on the left Side of the Diviſor is contained in the firſt Figure on the left Side of the Dividual, and place the Anſwer in the Quotient, and thereby multiply your Diviſor, placing your Product under your Dividual, and ſubtract it therefrom, placing the remainder below the Line; then put a Point under the next Figure in the Dividend, and draw it down to the ſaid Remainder, and annex it on the right Side thereof, which makes a new Dividual, and proceed as before, till the Work is finiſhed.

And if it ſo happen, that after you have choſen your firſt Dividual, (as is before directed) you find it to be leſſer than the Diviſor, then put a Point under the Figure more near to the right Hand, and ſeek how often the firſt Figure on the left Side of the Diviſor is contained in the two firſt Figures on the left Side of the Dividual, and place the Anſwer in the Quotient, by which multiply the Diviſor, and place the Product thereof in order, under the Dividual, and ſubtract it therefrom, and proceed as before.

Always remembering that in all Caſes of *Diviſion*, if after you have multiplied your Diviſor by the Figure laſt placed in the Quotient, if the Product be greater than the Dividual, then you muſt cancel that Figure in the Quotient, and inſtead thereof put a Figure leſſer by an Unit (or one) and multiply the Diviſor thereby, and if ſtill the Product be greater than the Dividual, make the Figure in the Quotient yet leſſer by an Unit, and thus do until your Product be leſſer than the Dividual, or at the moſt equal thereto, and then make Subtraction, *&c.*

So if you would divide 9464 by 24, the Quotient will be found to be 394; I firſt put down the given Number, as is before directed in the 3d Rule. Now becauſe my Diviſor conſiſteth of two Figures, I therefore put a Point under the ſecond Figure from the left Hand of my Dividend, which here is 4, wherefore I ſeek how often 2 the firſt Figure (on the left Side of the Diviſor) is contained in 9, the like firſt in the Dividual, the Anſwer is 4, which I put in the Quotient, and thereby multiply all the Diviſor, and find the Product to be 86, which is greater than the Dividual 94, wherefore I cancel the 4 in the Quotient, and inſtead thereof I put 3 (an

```
24)9464(39
  ...
  72
 ---
  226
  216
 ---
   10
```

an Unit leſſer) and by it multiply the Diviſor 24, and the Product is 72, which I ſubtract from 94 the Dividual, and the Remainder is 22; then do I make a Point under the next Figure 6 in the Dividend, and draw it down and place it on the right Side of the Remainder 22, and it makes 226 for a new Dividual; now becauſe the Dividual 226 conſiſteth of a Figure more than the Diviſor, therefore I ſeek how often 2 (the firſt Figure of the Diviſor) is contained in 22, the two firſt Figures of the Dividual, and I ſay 9 times, wherefore I put 9 in the Quotient, and thereby multiply the Diviſor 24, the Product (216) I place under the Dividual 226, and ſubtract it, and there remaineth 10.

```
24) 9464 (39
...
 72
----
 226
 216
----
  10
```

Then I go on and make a Point under the next and laſt Figure (4) in the Dividend, and draw it down to the Remainder 10, and it makes 104 for a new Dividual, which is alſo a Figure more than the Diviſor, and therefore I ſeek how often 2 is contained in 10, I anſwer 5 times; but multiplying my Diviſor by 5, the Product is 120, which is greater than the Dividual, and therefore I make it but 4, and by it multiply the Diviſor, and the Product is 96, which being placed under, and ſubtracted from the Dividual, there remaineth 8; and thus the whole Work of this Diviſion is ended, and I find that 9464 being divided by 24, or into 24 equal Parts, is found to be 394, as was ſaid before, and the Remainder is 8, as you ſee in the Work following.

```
24) 9464 (394
...
 72
----
 226
 216
----
 104
  96
----
 (8)
```

Another Example may be this: Let there be required the Quotient of 1183653 divided by 385: Firſt I diſpoſe of the Numbers in order to their dividing, and becauſe 118, the three firſt Figures of the Dividend, is leſſer than the Diviſor 385, I therefore make a Point under the fourth Figure, which is 3, and ſeek how often 3 (the firſt Figure of the Diviſor) is contained in 11: the Anſwer is 3, which I put in the Quotient, and thereby multiply the Diviſor 385, and the Product is 1155, which

```
385)1183653(3
...
 1155
-----
  28
```

which I ſubtract from the Dividual 1183, and there remai
28: Then, as before, I draw down the next Figure, whic
is 6, and place it before the Remainder 21, ſo have I 286 for
new Dividual, and becauſe it hath no more Figures than th

385)1183653(33
1155
286

Diviſor, I ſeek how often 3 (the firſt Figu
of the Diviſor) is contained in 2 (the fi
Figure of the Dividual) and the Anſwer
0; for a greater Number cannot be co
tained in a leſſer; wherefore I put 0 in the Quotient, an
thereby, according to the fifth Rule, I ſhould multiply th
Diviſor, but if I do the Product will be 0, and 0 ſubtracte
from the Dividual 286, the Remainder is the ſame; where
fore I draw down the next Figure (5) from the Dividen
and put it before the ſaid Remainder 28

385)1183653(507
1155
2865
2695
170

ſo have I 2865 for a new Dividual; an
becauſe it conſiſteth of four Places, vi
a Place more than the Diviſor, I ſeek ho
often 3, the firſt Figure of the Diviſor,
contained in 28, the two firſt of the D
vidual, and I ſay there is 9 times 3 in 2
but multiplying my whole Diviſor (385) thereby, I find th
Product to be 3465, which is greater than the Dividual 286
wherefore I chuſe 8, which is leſſer by an Unit than 9, an
thereby I multiply my Diviſor 385, and the Product is 308
which ſtill is greater than the ſaid Dividual; wherefore
chuſe another Number yet an Unit leſſer, *viz.* 7, and havin
multiplied my Diviſor thereby, the Product is 2695, whic
is leſſer than the Dividual 2865, wherefore I put 7 in th
Quotient, and ſubtract 2695 from the Dividual 2365, an
there remains 170; then I draw down the laſt Figure (3) f
the Dividend, and place it before the ſaid Remainder 17
and it makes 1703 for a new Dividual; then, for the Reaſo

385)1183653(3074
1155
2865
2695
1703
1540
(103)

above ſaid, I ſeek how often 3 is contai
ed in 17 the Anſwer is 5, but multipl
ing the Diviſor thereby, the Product
1925, greater then the Dividual, where
fore I ſay it will bear 4 (an Unit leſſe
and by it I multiply the Diviſor 385 an
the Product is 1540, which is leſſer tha
the Dividual, and therefore I put 4 i
the Quotient, and ſubtract the ſaid Pr
duct from the Dividual, and there remains 163; and th
the Work is finiſh'd, and I find that 1183653 being divide
by 385, or into 385 equal Shares or Parts, the Quotien
or one of thoſe Parts, is 3074, and beſides there is 16
remaining.

An

And thus the Learner being well verſed in the Method of the foregoing Examples, he may be ſufficiently qualified for the dividing of any greater Sum or Number into as many Parts as he pleaſeth; that is, he may underſtand the Method of dividing by a Diviſor which conſiſteth of 4, or 5, or 6, or any greater Number of Places, the Method being the ſame with the foregoing Examples in every reſpect.

Other Examples in Diviſion.

27986) 835684790 (29860
....
55972
275964
251874
240907
223888
170199
167916
Remain (22830)

196374) 473986018 (2413
....
392748
812380
785496
268841
196374
724678
589122
Remain (135556)

So if you divide 47386473 by 58736, you will find the Quotient to be 806, and 45257 will remain after the Work is ended.

In like manner; if you would divide 3846739204 by 483064, the Quotient will be 7963, and the Remainder after Diviſion will be 100572.

Compendiums in Diviſion.

1. IF any given Number be to be divided by another Number that hath Cyphers annexed on the right Side thereof, (omitting the Cyphers) you may cut off ſo many Figures from the right Hand of the Dividend, as there are Cyphers before the Diviſor, and let the remaining Numbers in the Dividend be divided by the remaining Numbers

of the Divisor, observing this Caution, That if after your Division is ended any thing remain, you are to annex thereto the Number or Numbers that were cut off from the Dividend, and such new found Number shall be the Remainder. (See *Mr. Oughtred's Clavis Mathematica*, cap. 5. 3.) As for Example, Let it be required to divide 46658 by 400; now because there are two Cyphers before the Divisor, I cut off as many Figures from before the Dividend, *viz.* 58, so that then there will remain only 466 to be divided by 4, and the Quotient will be 116, and there will remain 2, to which I annex the two Figures (58) which were cut off from the Dividend, and it makes 258 for the true Remainder; so that I conclude 46658 being divided by 400, the Quotient will be 116; and 258 remain after the Work is ended, as by the Work in the Margent.

```
4|00) 466|58 (116
      ...
      4
     ---
      6
      4
     ---
      26
      24
     ----
     (258)
```

2. And hence it followeth, that if the Divisor be 1, or an Unit with Cyphers annexed, you may cut off so many Figures from before the Dividend as there are Cyphers in the Divisor, and then the Figure or Figures that are on the left Hand will be the Quotient, and those that are on the right Hand will be the Remainder after the Division is ended. (*Vid. Gem. Frisi. Arith. par.* 1.) As thus; if 45783 were to be divided by 10, I cut off the last Figure (3) with a Dash, thus, 4578|3, and the Work is done, and the Quotient is 4578, the Number on the left Hand of the Dash, and the Remainer is 3, on the right Hand. In the like manner, if the same Number 45683 were to be divided by 100, I cut off two Figures from the End, thuss 457 83 and the Quotient is 457, and the Remainder is 83. And if I am to divide the same by 1000, I cut off three Figures from the End, thus, 45|783, and the Quotient is 45, and 783 is the Remainder, *&c.*

6. The general Effect of *Division* is contained in the Definition of the same, that is by having two unequal Numbers given, to find a third Number in such Proportion to the Dividend, as the Divisor hath to Unit or 1: It also discovers what Reason or Proportion there is between Numbers, so if you divide 12 by 4, it quotes 3, which shews the Reason or Proportion of 4 to 12 is triple.

The second Effect is, by the superficial Measure or Content, and the Length of any Oblong, Rectangular, Parallelogram, or square Plane known, to find out the Breadth thereby;

ereby; or contrarywiſe, by having the Superficies and readth of the ſaid Figure, to find out the Length thereof. lſo by having the Solidity and Length of a Solid, to find e Superficies of the Baſe, *& contra.*

The third Effect is, by the Contents, Reaſon, Price, Va-e, Bying, Selling, Expences, Wages, Exchange, Intereſt, rofit, or Loſs of any Number of Things, be it Money, lerchandize, or what elſe; to find out the Contents, Rea-n, Price, Value, Buying, Selling, Expence, Wages, Ex-hange, Intereſt, Profit or Loſs of any one Thing of the e Kind.

The fourth Effect is, to aid, to compoſe and to make her Rules, but principally the Rule of Proportion, called e *Golden Rule*, or *Rule of Three*, and the Reduction of lonies, Weights and Meaſures of one Denomination into nother; by it alſo Fractions are abbreviated, by finding a mmon Meaſure unto the Numerator and Denominator, ereby diſcovering commenſurable Numbers.

If you divide the Value of any certain Quantity by the me Quantity, the Quotient diſcovers the Rate or Value the Integer; as if 8 Yards of Cloth coſt 96 Shillings, if u divide (96) the Value or Price of the given Quantity, (8) the ſame Quantity, the Quotient will be 12, which the Price or Value of one of thoſe Yards.

I you divide the Value or Price of any unknown Quan-y by the Value of the Integer, it gives you in the Quo-nt that unknown Quantity, whoſe Price is thus divided; if 12 Shillings were the Value of a Yard, I would know w many Yards are worth 96 Shillings: Hence if you di-de 96, the Price or Value of the unknown Quantity, by , the Rate of the Integer, 1 or 1 Yard, the Quotient will 8, which is the Number of Yards worth 96*s.*

Some Queſtions anſwered by Diviſion may be theſe fol-wing.

Queſt. 1. If 22 Things coſt 66 Shillings, what will 1 ſuch hings coſt? *Facit* 3 Shillings; for if you divide 66 by 22, e Quotient is 3 for the Anſwer. So if 26 Yards or Ells any Thing be bought or ſold for 78*l.* how much will e Yard or Ell be bought or ſold for? *Facit* 3*l.* for if you ide 78 by 26 Yards, the Quotient will be 3*l.* the Price the Integer.

Queſt. 2. If the Expence, Charges or Wages of 7 Years ount to 868*l.* what is the Expence, Charges or Wages one Year? *Facit* 124*l.* for if you divide 868, the Wages 7 Years, by 7, the Number of Years, the Quotient will 124*l.* for the Anſwer. See the Work.

7) 868 (124

7

16

14

28

28

(0)

Queſt. 3. If the Content of one ſuperficial Foot be 14 Inches, and the Breadth of a Board be 9 Inches, how many Inches of that Board in Length will make ſuch Foot? *Facit* 16 Inches; for by dividing 144, the Numbe of ſquare Inches in a ſquare Foot, by 2, the Inches in th Breadth of the Board, the Quotient is 19 for the Numbe of Inches in the Length of that Board to make a ſuper ficial Foot.

9) 144 (16 *Inches*

9

54

54

(0)

Queſt. 4. If the Content of an Acre of Ground be 16 ſquare Perches, and the Length of a Furlong (propounde be 80 Perches, how many Perches will there go in Bread to make an Acre? *Facit* 2 Perches; for if you divide 16 the Number of Perches in an Acre, by 80, the Length the Furlong in Perches, the Quotient is 2 Perches, and many in Breadth of that Furlong will make an Acre.

80) 160 (2 Perches.

160

(0)

Queſt. 5. If there be 893 Men to be made up into a B tle, the Front conſiſting of 47 Men, what Number m there be in the File? *Facit* 19 deep in the File; for if y divide 893, the Number of Men, by 47, the Number the Front, the Quotient will be 19 in Depth of the F The Work followeth.

47) 893 (19 deep in File.

47

423

423

(0)

Queſt. 6. There is a Table whoſe ſuperficial Content is 72 Feet, and the Breadth of it at the End is 3 Feet; now I demand what is the Length of this Table? *Facit* 24 Feet long; for if you divide 72, the Content of the Table in Feet, by 3, the Breadth of it, the Quotient is 24 Feet for the Length thereof, which was required. See the Operation in the Margent.

```
3) 72 (24
    6
   ---
    12
    12
   ---
    (0)
```

The Proof of Multiplication *and* Diviſion.

Multiplication and *Diviſion* interchangeably prove each other; for if you would prove a Sum in *Diviſion*, whether the Operation be right or no, multiply the Quotient by the Diviſor, and if any thing remain after Diviſion is ended add it to the Product, which Product, if your Sum was rightly divided, will be equal to the Dividend. And contrarywiſe, if you would prove a Sum in *Multiplication*, divide the Product by the Multiplier, and if the Work was rightly performed the Quotient will be equal to the Multiplicand. See the Example, where the Work is done and undone. Let 7654 be given to be multiplied by 3242, the Product will be 24814268, as by the Work appeareth.

```
  7654
  3242
 -----
 15308
 30616
 15308
 22962
 -----
 24814268
```

And then if you divide the ſaid Product 24814268 by 3242 the Multiplier, the Quotient will be 7654, equal to the given Multiplicand.

```
3242) 24814268 (7654
      ...
      22694
      -----
       21202
       19452
       -----
        17506
        16210
        -----
         12968
         12968
         -----
          (0)
```

In like manner (to prove a Sum or Number in *Diviſion*) if 24814268 were divided by 3242, the Quotient will be found to be 7654; then for Proof, if you multiply 7654 the Quotient, by 3242 the Diviſor, the Product will amount to 24814268, equal to the Dividend

Or, you may prove the laſt, or any other Example in *Multiplication*, thus, *viz.* divide the Product by the Multiplicand, and the Quotient will be equal to the Multiplier. See the Work.

7654

7654
3242
15308
30616
15308
22962
7654) 24814268 (3242
....
22962
18522
15308
32146
30616
15309
15308
(0)

From whence there arises this Corollary, that any Operation in *Division* may be proved by *Division*; for if, after your *Division* is ended, you divide the Dividend by the Quotient, the new Quotient thence arising will be equal to the Divisor of the first Operation; for Tryal whereof let the last Example be again repeated.

3242) 24814268 (7654
....
22694
21202
19452
17506
16210
12968
12968
(0)

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the first Divisor 3242. See the Work.

7654) 24814268 (3242
....
22962
18522
15308
32146
30616
15308
15308
(0)

But

Bot in proving Diviſion by Diviſion, the Learner is to obſerve this following Caution; That if after his Diviſion is ended, there be any Remainder, before you go about to prove your Work, ſubtract the Remainder out of your Dividend, and then work as in the following Example, where it is required to divide 43876 by 765; the Quotient here is 57, and the Remainder is 271. See the Work following.

765) 43876 (57
3825
5626
5355
(271)

Now to prove this Work, ſubtract the Remainder 271 out of the Dividend 43876, and there remaineth 43605, for a new Dividend to be divided by the former Quotient 57, and the Quotient thence ariſing is 765, equal to the given Diviſor, which proveth the Operation to be right.

43876
271
57) 43605 (765
399
370
342
285
285
(0)

Thus we have gone through the four Species of *Arithmetick*, viz. *Addition*, *Subtraction*, *Multiplication* and *Diviſion*, upon which all the following Rules, and all other Operations whatſoevor that are poſſible to be wrought by Numbers, have their immediate Dependance, and by them are reſolved. (Vide *Gem. Friſ.* Arith. par. 1.) Therefore before the Learner make a farther Step in this Art. let him be will acquainted with what has been delivered in the foregoing Chapter.

CHAP. VIII.

Of Reduction.

1. *REDUCTION* is that which brings together two or more Numbers of different Denominations into one Denomination; (*Hill's* Arith. c. 13.) or it ſerveth to change or alter Numbers, Money, Weight, Meaſure or Time, from one Denomination to another; and likewiſe, to abridge Fractions to the loweſt Terms: All which it doth ſo preciſely, that the firſt Proportion remaineth without the leaſt Jot of Error or Wrong committed; ſo that it belongeth as well to Fractions as Integers, of which in the proper Place. *Reduction* is generally performed either by *Multiplication* or *Diviſion*; from whence we may gather, That

2. *Reduction* is either deſcending or aſcending.

3. *Reduction* deſcending, is when it is required to reduce a Sum or Number of a greater Denomination into a leſſer; which Number, when it is ſo reduced, ſhall be equal in Value to the Number firſt given in the greater Denomination; (*Wing.* Arith. 7, 2, 3, 4.) as if it were required to know how many Shillings, Pence or Farthings are equal in Value to 200*l.* or how many Ounces are contained in 45 C. Weight; or how many Days, Hours or Minutes there are in 240 Years, *&c.* And this Kind of *Reduction* is generally performed by *Multiplication.*

4. *Reduction* aſcending, is when it is repuired to reduce or bring a Sum or Number of a ſmaller Denomination into a greater, which ſhall be equivalent to the given Number; as ſuppoſe it were required to find out how many Pounds, Shillings or Pence are equal in Value to 43785 Farthings; or how many Hundreds are equal to, or in 3748 Pounds, *&c.* And this Kind of *Reduction* is always performed by *Diviſion.*

5. When any Sum or Number is given to be reduced into another Denomination, you are to conſider whether it ought to be reſolved by the Rule deſcending, or aſcending, *&c* by *Multiplication* or *Diviſion*: If it be to be performed by *Multiplication,* conſider how many Parts of the Denomination into which you would reduce it are contain'd in an Unit or Integer of the given Number, and multiply the ſaid given Number thereby, and the Product thereof will be the Anſwer to the Queſtion. As if the Queſtion were, In 38 Pounds how many Shillings? Here I conſider,

conſider, that in a Pound are 20 Shillings, and that the Number of Shillings in 38*l.* will be 20 times 38, wherefore I multiply 38*l.* by 20, and the Product is 760, and ſo many Shillings are contained in 38*l.* as in the Margent.

38
20
760

But when there is a Denomination or Denominations between the Number given and the Number required, you may, if you pleaſe, reduce it into the next inferior Denomination, and then into the next lower than that, *&c.* untill you have brought it into the Denomination required. As for Example, Let it be demanded in 132 Pounds how many Farthings? Firſt, I multiply 132, the Number of Pounds given, by 20, to bring it into Shillings, and it makes 2640 Shillings, then do I multiply the 2640 Shillings by 12, to bring them into Pence, and it produceth 31680, and ſo many Pence are contained in 2640 Shillings, or 132 Pounds; then do I multiply the Pence, *viz.* 31680 by 4, to bring them into Farthings (becauſe 4 Farthings is a Penny) and I find the Product thereof to be 126720, and ſo many Farthings are equal in Value to 132 Pounds. As by the Work in the Margent.

132 Pounds
20
2640 Shil.
12
5280
2640
31680 Pence
4
126720 Farth.

6. And if the Number propounded to be reduced is to be divided, or wrought by the Rule aſcending, conſider how many of the given Number are equal to an Unit or Integer, in that Denomination to which you would reduce your given Number, and make that your Diviſor, and the given Number your Dividend: and the Quotient thence ariſing will be the Number ſought or required. As for Example, Let it be required to reduce 2640 Shillings into Pounds. Here I conſider that 20 Shillings are equal to one Pound, wherefore I divide 2640, the given Number, by 20, and the Quotient is 132; and ſo many Pounds are contained in 2640 Shillings. In *Reduction* deſcending and aſcending, the Learner is adviſed to take particular Notice of the Tables delivered in the ſecond Chapter of this Boook, where he may be informed what Multipliers and Diviſors to mak uſe of in the reducing of any Number to any other Denomination whatſoever, eſpecially *Engliſh* Money, Weights, Meaſures, Time, and Motion: But in this Place it is not convenient to meddle with foreign Coins, Weights or Meaſures.

l.

20)2640(132

20

64

60

40

40

---

(0)

But if, in *Reduction* aſcending, it happens that there is a Denomination or Denominations between the Number given and the Number required, then you may reduce your Number given into the next ſuperior Denomination, and when it is ſo reduced, bring it into the next above that, and ſo on until you have brought it into the Denomination required. As for Example, Let it be demanded in 126720 Farthings how many Pounds? Firſt, I divide my given Number, being Farthings, by 4, to bring them into Pence, becauſe 4 Farthings make one penny, and there are 31680 Pence; then I divide 31680 Pence by 12, and the Quotient giveth 2640 Shillings; and then I divide 2640 Shillings by 20, and the Quotient giveth 132 Pounds, which are equal in Value to 126720 Farthings. See the whole Work as it followeth.

```
                    12)     20)     l.
4) 126720 (31680 (2640 (132
    ....    ...    ..
   12      24      2
   --      --      -
    6      76      6
    4      72      6
   --      --      -
    27     48      4
    24     48      4
   --      --      -
    32     (0)     (0)
    32
   --
   (0)
```

l. *s.* *d.*
48 13 10
20
960 *Shil.*
Add 13
Sum 973
12
1946
973
11676 *Pence*
Add 10
Sum 11686

7. When the Number given to be reduced conſiſteth of divers Denominations, as *Pounds*, *Shillings*, *Pence* and *Farthings*; or of *Hundreds*, *Quarters*, *Pounds* and *Ounces*, &c. then you are to reduce the higheſt, or greateſt, Denomination into the next inferior, and add thereunto the Number ſtanding in the Denomination which your greateſt or higheſt Number is reduced to; then reduce that Sum into the next inferior Denomination, adding thereto the Number ſtanding in that Denomination; do ſo until you have brought the Number given into the Denomination propoſed. As if it were required to reduce 48*l.* 13*s.* 10*d.* into Pence: Firſt, I bring 48*l.* into Shillings, by multiplying it by 20, and the Product is 960 Shillings, to which I add the 13 Shillings, and they make 973; then I multiply 973 by 12,

to

to bring the Shillings into Pence, and they make 11676 Pence, to which I add the 10*d.* and they make 11686 Pence for the Answer. See the Work done.

8. If, in *Reduction* ascending, after Division is ended, any thing remain, such Remainder is of the same Denomination with the Dividend.

Example. In 4783 Farthings, I demand how many Pounds?

First, I divide the given Number of Farthings, *viz.* 4783, by 4, to bring them into Pence, and the Quotient is 1195 Pence, and there remaineth 3 after the Work of Division is ended, which is 3 Farthings.

Again; I divide 1195 Pence (the said Quotient) by 12, to reduce them into Shillings, and the Quotient is 99 Shillings, and there is a Remainder of 7, which is 7 Pence.

And then I divide 99 Shillings (the last Quotient) by 20, to bring it into Pounds, and the Quotient is 4*l.* and there remaineth 19 Shillings; so I conclude that in 4783, the proposed Number of Farthings, there is 4 Pounds, 19 Shillings, 7 Pence, 3 Farthings. View the following Operation.

```
                12)      20
4) 4783  (1195    (99     (4 Pounds
  ...
  4      108      8
  7      115     (19) Shillings.
  4      108
 38 Rem.(7) Pence
 36
 23
 20
Rem. (3) Farthings.
```

l. *s.* *d.qrs.*
4 19 07 3

More Examples in Reduction of Coin.

Queſt. 1. In 438*l.* how many Shillings? *Facit* 8760 Shillings; for by multiplying the 438 by 20, the Product amounteth to so much. See the Work in the Margent.

438 *l.*
20
Facit 8760 *s.*

Queſt. 2. In 467*l.* how many Pence? First, multiply the given Number of Pounds (467) by 20, to bring it into Shillings, and it makes 9340 Shillings; then multiply the Shillings by 12, and it produceth 112080 Pence, as in the Margent.

467 Pounds
20
9340 Shil.
12
18680
9340
Facit 112080 Pence

467 Pounds
240
18680
934
Facit 112080 Pence

Or it may be resolved thus, *viz.* multiply the given Number of Pounds 467, by 240, the Number of Pence in a Pound, and the Product is the same, *viz.* 112080 Pence as by the Operation appeareth.

Quest. 3. In 5673*l.* how many Farthings? First, multiply the given Number by 20, to bring it into Shillings, and it produceth 113460 Shillings; then multiply that Product by 12, to bring it into Pence, and it produceth 1361520 Pence; then, lastly, multiply the Pence by 4, and it produceth 5446080 Farthings.

5673 Pounds
20
113460 Shillings
12
226920
113460
1361520 Pence
4
Facit 5446080 Farthings

Or this Question might have been thus resolved, *viz.* multiply 5673, the given Number of the Pounds, by 960, the Number of Farthings in a Pound, and it produceth the same Effect, as you may see by the Work.

5673 Pounds
960
340380
51057
Facit 5446080 Farthings

20 Shillings
12
240 Pence
4
960 Farthings

Otherwise thus: First bring the given Number 5673*l.* into Shillings, and multiply the Shillings by 48, the Number of Farthings in a Shilling, and they same Effect is thereby likewise produced, *viz.*

5673 Pounds
20
113460 Shillings
48
907680
453840
Facit 5446080

12 Pence
4
48

These various Ways of Operation are expressed to inform the Judgment of the Learner with the Reason of the Rule. More Ways may be shewn, but these are sufficient even for the meanest Capacities.

Quest.

Queſt. 4. In 458*l.* 16*s.* 7*d.* 3*qrs.* how many Farthings? To reſolve this Queſtion, conſider the 7th Rule of this Chapter, and work as you are there directed, and you will find the aforeſaid given Number to amount to 440479 Farthings, *viz.*

	l.	*s*	*d.*	*qrs.*
	458	16	7	3
	20			
	9160			
Add	16	Shillings		
Sum	9176	Shillings		
	12			
	18352			
	9176			
	110112	Pence		
Add	7			
Sum	110119			
	4			
	440476	Farthings		
Add	3			
Sum	440479	Farthings		

This laſt Queſtion, or any other of this Kind, may be more conciſely reſolved thus, *viz.* When you multiply the Pounds by 20, to bring them into Shillings, to the Product of the firſt Figure add the Figure ſtanding in the place of Units in the Denomination of Shillings; but becauſe the firſt Figure in the Multiplier is 0, I ſay, 0 times 8 is nothing, but 6 is 6, which I put down for the firſt Figure in the Product, then becauſe the Multiplier is 0, I go on no further with it for if I ſhould the whole Product will be 0, but proceed, and when I come to multiply by the ſecond Figure in the Multiplier, to the Product of it I add the Figure ſtanding in the place of Tens in the Denomination of Shillings, which is 1, ſaying, 2 times 8 is 16, and the ſaid Figure 1 is 17; then I ſet down 7, and carry the Unit to the Product of the next Figure, as is directed in the 5th Rule of the 6th Chapter foregoing, and finiſh the Work; ſo that now you may have the whole Product and Sum of Shilings at one Operation, which is the ſame as before; and when you multiply the Shillings by 12, to bring them into Pence (after the ſame manner) add to the Product the Number ſtanding in the Denomination of Pence, and ſo when you multiply the Pence by 4, to bring them into Farthings, add to the Product the Number ſtanding under the Denomination of Farthings. See the laſt Queſtion thus wrought.

458

l. *s.* *d.* *qrs.*
458 16 7 3
20
9176 Shillings
12
18359
9176
110119
4
Facit 440479 Farthings.

After the Method last prescribed are all the following Examples, that are of the same Nature, wrought and resolved.

Quest. 5. In 4375866 Farthings, I demand how many Pounds, Shillings and Pence?

To resolve this Question, First, I divide the given Number of Farthings by 4, and Quotient is 1093966 Pence and there remaineth 2 after the Division is ended, which (by the 8th Rule foregoing) is two Farthings; then I divide 1093966 Pence by 12, and the Quotient is 91163 Shillings and there remaineth 10 after Division, which, by the said 8th Rule is so many Pence, *viz.* 10*d.* then I divide 91163 Shillings by 20, and the Quotient is 4558*l.* and there remaineth 3 Shillings, so the Work is finish'd and I find that in 4375866 Farthings, there are 4558*l.* 3*s.* 10*d.* 2*qrs.* See the Operation.

12 20) *l.*
4)4375866, 1093966, 91163, 4558
4 108 8
37 13 11
36 12 10
15 19 11
12 12 10
38 76 16
36 72 16
26 40 (3*s.*
24 36
26 (10) *d.*
24
(2) *qrs.*

l. *s.* *d.* *qrs.*
Facit 4558 3 10 2.

Quest.

Queſt. 6. In 4386*l.* I demand how many Groats?

To reſolve this Queſtion, I reduce the given Number of Pounds into Shillings, and they are 87720 Shillings; now conſider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats. See the Work.

4386 Pounds
20
87720 Shillings
3
Facit 263160 Groats

Thus Queſtion might have been otherwiſe reſolved thus, *viz.* conſidering that in a Pound (or 20 Shillings) there are three times 20 Groats, which makes 60, by which I multiply the Number of Pounds given, and it produceth the ſame Effect at one Operation, as followeth.

4386 Pounds
60 Groats in 20*s.*
Facit 263160 Groats in 4386 *l.*

Queſt. 7 In 43758 Three-pences, I deſire to know how many Pounds?

To reſolve this, and many ſuch like Queſtions, Firſt, I divide my given Number of Three-pences by 4, becauſe 4 Three-pences are in a Shilling, and the Quotient is 10939 Shillings, and there remaineth 2 after Diviſion is ended, which is 2 Three-pences (by the 8th Rule of this Chapter) which are equal in Value to 6*d.* then I divide 10939 Shillings by 20, and the Quotient giveth 546*l.* and 19*s.* remains; ſo that I conclude in 43758 Pieces, of Three-pence per piece, there are 546*l.* 19*s.* 6*d.* as by the Work appeareth.

20 *l.* *s.* *d.*
4) 43758 (10939 (546 19 6
4 10
37 9
36 8
15 13
12 12
38 19 Shillings
36
(2) Three-pences, or 9*d.*

This

The Question might have been otherwise resolved th *viz.* First, multiply the given Number of Three-penc 43758, by 3, the Number of Pence in Three-pence, a the Product, *viz.* 131274 is the Number of Pence equal the given Number of Three-pences, which Number Pence may be brought into Pounds by dividing by 12, a by 20, and the Quotient you will find to be equal to t former Work, 546*l.* 19*s.* 6*d.*

```
           43758
               3
      ----------- 2|0        l.    s.   d.
  12) 131274 (1093|9 (546   19    6
       ....      ..
       12        10
       ---      ---
       112        9
       108        8
       ---      ---
        47       13
        36       12
       ---      ---
       114 re. (19) Shillings
       108
       ---
        (6) pence remains
```

Or thus, Divide the given Number of Three-pences b the Number of Three-pences in a Pound, or 20 Shillin (which you will find to be 80, if you multiply 20*s.* by the Number of Three-pences in a shilling,) and you wi find the Quotient to be 546*l.* as before, and a Remaind of 78 Three-pences; and if you divide those 78 Thre pences by 4, because there are 4 Three-pences in a Shi ling, you will find the Quotient to be 19*s.* and 2 Thre pences remain, which are equal to 6*d.* which is the sam that was before found.

```
  8|0)4375|8 (546  19  6          20
        ..                         4
      40                          --
      --                          80
      37
      32
      --
      55
      48
      --
   4) 78 (19s.
      .
      4
      --
      38
      36
      --
      (2) Three-pences, or 6d.
```

Quest.

Queſt. 8. In 4785*l.* 13*s.* how many Pieces of 13*d.* ½ per Piece?

This Queſtion cannot be reſolved by Reduction deſcending or aſcending abſolutely, becauſe 13*d.* ½ is no even part of a Pound, but rather by them jointly, *viz.* by Multiplication and Diviſion; but if you bring the Number given into Half-pence, and divide the Half-pence by the Half-pence in 13*d.* ½ *viz.* 27, the Quotient will be the Anſwer: For having brought 4785*l.* 13*s.* into Half-pence, I find it makes 2297112, which I divide by 27, becauſe there are ſo many Half-pence in 13*d.* ½, and the Quote gives 85078 Pieces of 13*d.* ½, and 6 Half pence remain over and above. Obſerve the Work following.

l.	*s.*	*d.*
4785	13	13 ½
20		2
95713 Shillings		27 Half-pence
24 Half-pence in a Shilling		
382852		
191426		
2297112 Half-pence is the given Number		

27)2297112(85078 Pieces of 13*d.* ½

216

137

135

211

189

222

216

Remain (6) Half-pence

It would have produced the ſame Anſwer, if you had reduced your given Number into Farthings, and divided by the Farthings in 13*d.* ½, *viz.* 54, (for always the Dividend and the Diviſor muſt be of one Denomination) and then

then you would have had a Remainder of 12 Farthing which are equal in Value to the former Remainder of Half-pence, as you may prove at your Leisure.

Quest. 9. In 540 Dollars, at 4*s.* 4*d. per* Dollar, how many Pounds sterling?

First, bring your given Number of Dollars into Pence and then your Pence into Pounds, according to the former Directions, thus, in 4*s.* 4*d. viz.* a Dollar, you will find 52 Pence, by which multiply 540 Dollars, and it produceth 28080 Pence, which if you divide by 240, the Pence in one Pound, the Quotient will give you 117*l.* which are equal in Value to 540 Dollars, at 4*s.* 4*d. per* Dollar.

	s.	*d.*
540	4	4
52	12	
1080	52	
2700		
240) 28080 (117		
24		
40		
24		
168		
168		
(0)		

The foregoing Question might have been otherwise wrought thus, *viz.* multiply 540, your given Number of Dollars, by 13 the Number of Groats in a Dollar, or 4*s.* 4*d.* and it produceth 7020 Groats, which divide by 60, the Groats in one Pound, or 20 Shillings and the Quotient 117, as before. See the Work.

	s.	*d.*
540	4	4
13	13	
1620	13	
540		
60) 7020 (117		
6		
10		
6		
42		
42		
(0)		

Ques

Queſt. 10. In 547386 Pieces of 4*d.* ½ *per* Piece, I demand how many Pounds, Shillings and Pence?

Firſt bring your given Number of Four-pence Half-penny all into Half-pence, which you will do if you multiply by 9, the Number of Half pence in 4*d.* ½, and the Product is 4926474 Half-pence, which are brought into Pounds, if you divide them by 24, the Half-pence in a Shilling, and 20, the Shillings in a Pound, it makes 10263*l.* 9*s.* 9*d.*

		d	
		4 ½	
547386		2	
9			
2|0	*l.*		9 Half-pence
24) 4926474	(20526|9	(10263.	
48	20		
126	05		
120	4		
64	12		*l.* *s.* *d.*
48	12	*Facit*	10263 9 9
167	6		
144	6		
234 rem. (9) Shillings			
216			

Remains (18) Half-pence, or 9*d.*

Queſt. 11. In 4368*l.* I demand how many Pieces of 6*d.* of 4*d.* and of 2*d.* of each an equal Number? That is to ſay, What Number of Six-pences, Groats and Two-pences will make 4368*l.* and the Number of each equal?

The Way to reſolve Queſtions of this Nature, is to add the ſeveral Pieces into which the given Number is to be brought into one Sum, and reduce the given Number into the ſame Denomination with their Sum, and to divide the ſaid given Number ſo reduced by the ſaid Sum, and the Quotient will give you the exact Number of each Piece: And after the ſame Method will we proceed to reſolve the preſent Queſtion, *viz.*

4386 Pounds
240 Pence
175440
8772
12) 1052640 (87720
....
96
92
84
86
84
24
24
(0)

6*d.*
4*d.*
2*d.*
Sum 12

d. *d.*
Facit 87720 Pieces of 6 4

So that I conclude by the Operation, that 87720 Sixpences, and 87720 Groats, and 87720 Two-pences, are juſt as much, or equal to 4386*l.* or if you admit of 5 to be thus divided, it is equal to 5 Sixpences, and 5 Four-pences or Groats, and 5 Two-pences.

Another Queſtion of the ſame Nature with the laſt may be this following, *viz.*

Queſt. 12. A Merchant is deſirous to change 148*l.* into Pieces of 13*d.* ½, of 12*d.* of 9*d* of 6*d* and of 4*d.* and he will have of each ſort an equal Number of Pieces, I deſire to know the Number?

Do as you were taught in the laſt Queſtion, *viz.* add the ſeveral Pieces together, and reduce the Sum into Half-pence; then reduce the Sum to be changed, *viz.* 148*l.* into the ſame Denomination, and divide the greater by the leſſer, and in the Quotient you will find the Anſwer, *viz.* 798, which is the Number of each of the Pieces required, and 18 remaineth, which is 18 Half-pence, by the 8th Rule of this Chapter. See the Work as followeth.

148

l.		*d.*
148		13 ½
240		12
		9
5920		6
296		4
35520	Pence in 148*l.*	Sum 44 ½
2		2
71040	Half-pence	89 Halfp.

89) 71040 (798 Pieces of each Sort

623

874
801

730
712

Rem. (18) Half-pence.

The Truth of the two foregoing Operations will thus be proved, *viz.* multiply the Anſwer by the Parts or Pieces into which the given Number was reduced, and having added the ſeveral Products together, if their Sum be equal to the given Number the Anſwer is right, otherwiſe not; ſo the Anſwer to the 11th Queſtion was 87720, which is proved as followeth, *viz.*

		l.
87720	Six-pences make	2193
	Four-pences make	1462
	Two-pences make	731

The total Sum of them 4386 which was the Sum given to be changed.

The Anſwer to the 12th Queſtion was 798, and 18 Half-pence remained after the Work was ended; now the Truth of the Work may be proved as the former, *viz.*

		l.	*s.*	*d.*
798	Pieces of 13*d.* ½ make	44	17	9
	Pieces of 12 make	39	18	0
	Pieces of 9 make	29	18	6
	Pieces of 6 make	19	19	0
	Pieces of 4 make	13	06	0
and 18 Half-pence, or 9*d.* remain		00	00	9
The total Sum of them		148	00	0

which total Sum is equal to the Number that was firſt given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy-weight.

We come now to give the Learner a few Examples in Troy-weight; in working whereof he muſt be mindful of the Table of Troy-weight delivered in the ſecond Chapter of this Book.

Queſt. 13. In 482lb. 7 *oz.* 13 *pwt.* 21 *gr.* how many Grains?

lb	*oz.*	*pwt.*	*gr.*
482	7	13	21
12			
971			
482			
5791 Ounces			
20			
115833 Penny-weight			
24			
463333			
231668			
Fac. 2780013 Grains			

Multiply by 12, by 20, and by 24, taking in the Figures ſtanding in the ſeveral Denominations; according to the Direction given in the ſeventh Rule of this Chapter, and you will find the Product to be 2780013 Grains, which is the Number required, to Anſwer to the Queſtion. See the whole Work, as in the Margent.

Queſt. 14. In 2780013 Grains, I demand how many Pounds, Ounces, Penny-weights and Grains?

This is but the foregoing Queſtion inverted, and is reſolved by dividing by 24, by 20, and by 12, and the Anſwer is 482lb 7 *oz.* 13 *pwt.* 21 *gr.*

2|0 12

4) 27800|13 (11583|3 (5791 (482 lb

24 10 48

38 15 99
24 14 96

140 18 31
120 18 24

200 3 Rem. 7 Ounces
192 2

81 Rem. 13 Peny-weight
72

93
72

Remains 21 Grains.

	lb	oz.	pwt.	gr.
Facit	482	7	13	21

Queſt. 15. A Merchant ſent to a Goldſmith 16 Ingots of Silver, each containing in Weight 2 lb 4 *oz.* and ordered it to be made into Bowls of 2 lb 10 *oz. per* Bowl, and Tankards of 1 lb 6 *oz. per* Piece, and Salts of 10 *oz.* 10 *pwt.* per Salt, and Spoons of 1 *oz.* 18 *pwt. per* Spoon, and of each an equal Number; I deſire to know how many of each ſort he muſt make?

This Queſtion is of the ſame Nature with the 11th and 12th Queſtion foregoing, and may be anſwered after the ſame Method, *viz.* Firſt, add the Weight of the ſeveral Veſſels into which the Silver is to be made into one Sum, and reduce it to one Denomination, and they make 1248 Peny-weights; then reduce the Weight of the Ingot into the ſame Denomination, *viz.* Penny-weights, and it makes 560 Penny-weights, and multiply them by the Number of Ingots, *viz* 16, and the Product will give you the Weight of the 16 Ingots, *viz.* 8960; then divide the Product by the Weight of the Veſſels, *viz.* 1248, and the Quotient giveth you the Anſwer to the Queſtion, *viz.* 7, and 224 *pwt.* remaineth over and above.

2 lb

lb	oz.
2	4
12	
28	
20	
560	Penny-weights
16	Ingots
3360	
560	
1248)8960(7	Veſſels of each
8736	
Rem. 224	Penny-weights

lb	oz. pw
2	08
1	06
0	10
0	01
Sum 5	02
12	
62	
20	
1248	

The Proof of the Work is as followeth, viz.

					lb	oz. pw
7	Bowls	of 2	08	00 *per* Bowl, is	18	08
	Tankards	of 1	06	00 *per* Tank. is	10	06
	Salts	of 0	10	10 *per* Salt, is	06	01
	Spoons	of 0	01	18 *per* Spoon, is	01	01
	224 Penny-weight remaining				00	11
					37	04

So that you ſee the Sum of the Weight of each Veſſe together with the Remainder, is 37 lb 4 oz. which is equ to the Weight of the 16 Ingots delivered; for if 37 4 oz. be reduced to Penny-weights, it makes 8960.

Reduction of Averdupois-weight.

In reducing Averdupois-weights, the Learner muſt ha Recourſe to the Table of Averdupois-weight, delivered the ſecond Chapter.

Qu

Queſt. 16. In 47 *C.* 1 *qr.* 20 lb how many Ounces? Multiply by 4, by 28, and 16, and the laſt Product will be the Anſwer, *viz.* 84992 Ounces. See the Margent.

C.	*qr.*	lb
47	1	20
4		
189 Quarters		
28		
1512		
380		
5312		
16		
31872		
5312		

Facit 84992 Ounces

Queſt. 17. In 84992 Ounces, I demand how many *C. qrs.* lb and *oz.*

This is the foregoing Queſtion inverted, and will be reſolved, if you divide by 16, by 28, and by 4, and the Anſwer is 47 *C.* 1*qr.* 20lb equal to the given Number in the foregoing Queſtion.

16) 84992 (5312	28) (189	4) (47	*C.*	*qr.*	lb	*oz.*
			47	1	20	00
80	28	16				
49	251	29				
48	224	28				
19	272	(1)*qr.*				
16	252					
32	(20) lb					
32						
(0)						

Reduction of Liquid Measure.

Queſt. 18. In 45 Tuns of Wine, how many Gallons? Multiply by 4, and by 63, the Product is 11340 Gallons for the Anſwer.

45
4
180
63
540
1080
Facit 11340 Gallons

Queſt. 19. In 34 Rundlets of Wine, each containing 18 Gallons, I demand how many Hogſheads?

Firſt, I find how many Gallons are in the 34 Rundlets, which you may do if you multiply 34 by 18, the Content of a Rundlet, and the Product is 612 Gallons, which you may reduce into Hogſheads, if you divide them by 63, and the Quote will be 9 Hogſheads and 45 Gallons. See the Work.

34
18
272
34
63) 612 (9 hhds.
567
Facit 9 hhds, 45 Gal.
Rem. 45 Gallons

Queſt. 20. In 12 Tun, how many Rundlets of 14 Gallons *per* Rundlet.

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Rundlet, and the Quotient 216, is your Anſwer. See the Work following.

12
4
48
63
144
288
14) 3024 (216 Rundlets
28
22
14
84
84
(0) *Facit* 216 Rundlets.

Reduction of Long Measure.

Queſt. 21. I demand how many Furlongs, Poles, Inches and Barly-corns will reach from *London* to *York*, it being accounted 151 Miles?

151 Miles
8 Furlongs in a Mile
1208 Furlongs
40 Poles in a Furlong
48320 Poles
11 Half-yards in a Pole
48320
48320
531520 Half-yards
18 Inches in half a Yard
4252160
531520
9567360 Inches
3 Barly-corns in one Inch

Facit 28702080 Barly-corns in 151 *Engliſh* Miles.

Queſt. 22. The Circumference of the Earth (as all other Circles are) is divided into 360 Degrees, and each Degree into 60 Minutes, which (upon the Superficies of the Earth) are equal to 60 Miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet and Barly-corns will reach round the Globe of the Earth?

360 Degrees
60 Minutes or Miles in a Degree
21600 Miles about the Earth
8 Furlongs in a Mile
172800 Furlongs about the Earth
40 Perches in a Furlong
6912000 Poles or Perches about the Earth
11 Half-yards in a Perch
6912000
6912000
2)76032000 Half-yards upon the Earth
)38016000 Yards, *viz.* the Half yards divided by 2
3
114048000 Feet about the Earth
12 Inches in a Foot
228096000
114048000
1368576000 Inches about the Earth
3 Barly-corns in an Inch
4105728000 Barly-corns

And so many will reach round the World, the whole being about 21600 Miles; so that if any Person were to go round, and go 15 Miles every Day, he would go the whole Circumference in 1440 Days, which is 3 Years, 11 Months, and 15 Days.

Reduction of Time.

Quest. 23. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes?

Years	*Weeks*	*Days*	*Hours*	*Min.*
28	24	4	16	30

52 Weeks in a Year.

60
142

1480 Weeks
7

10364 Days
24

41462
20729

248752 Hours
60

14925150

Note, That in resolving the last Question after the Method expressed, there is lost in every Year 30 Hours: for the Year consisteth of 365 Days and 6 Hours, but by multiplying the Year by 52 Weeks, which is but 364 Days, you lose 1 Day and 6 Hours every Year; wherefore to have an exact Answer, bring the odd Weeks, Days and Hours into Hours, and then multiply the Years by the Number of Hours in the Year, *viz.* 8766, and to the Product add the Hours contained in the odd Time, and you have the exact Time in Hours, which bring into Minutes as before. See the last Question thus resolved;

Days	*Hours*
28	365 6
8766	24
172	1466
172	730
197	8766 Hours in a Year
228	

249592 Hours, add 30 min. in Mult.
66

14975550 Minutes in 28 Years, 4144 Hours and 30 Minutes.

Week.	*Days*	*Hours*
24	4	16
7		
172		
24		
694		
345		
4144	Hours add in (Mult.	

So you see that according to the Method first used to resolve this Question, the Hours contained in the given Time are 248752; but according to the last, best, or truest Method, they are right, which exceeds the former by 840 Hours.

But for most Occasions it will be sufficient to multiply the given Years by 365, and to the Product add the Days in the odd Time, if there be any, and then there will be only a Loss of 6 Hours in every Year, which may be supplied by taking a fourth Part of the given Years, and adding it to the contained Days, and you have your Desire.

Quest. 24. In 43865340 Minutes, how many Years? *Facit* 834 Years, 4 Days, 19 Hours.

60)43865340(731095(834 — 8766 *Years* — *Days* 4 — *Hours* 19

42	70128
18	29815
18	26298
6	35179
6	35064
57	24) 115 (4 Days.
54	96
35	Rem. (19) Hours
30	
54	
54	
(0)	

Quest 25. I desire to know how many Hours and Minutes it is since the Birth of our Saviour *Jesus Christ*, being accounted 1756 Years.

This

This Queſtion is of the ſame Nature with the 24th foregoing, and after the ſame Manner is reſolved, *viz.* multiply the given Number of Years by 8766, the Product is 15393096 Hours, and that by 60, and the Product is 923585760 Minutes. See the Work.

1756 Years
8766 Hours in a Year

10536
10536
12292
14048

15393096 Hours in 1756 Years
60

923585760 Minutes in 1756 Years

Note, That as Multiplication and Diviſion do interchangeably prove each other, ſo Reduction deſcending and aſcending prove each other by inverting the Queſtion, as the 13th and 14th, and likewiſe the 16th and 17th Queſtions foregoing, by Inverſion, do interchangeably prove each other. The like may be performed for the proof of any Queſtion in Reduction whatſoever.

CHAP. IX.

Of Comparative Arithmetick, viz. *the Relation of Numbers one to another.*

1. COmparative Arithmetick is that which is wrought by Numbers, as they are conſidered to have Relation one to another, and this conſiſts either in Quantity or in Quality. *Vide* Boetus's *Arith. lib.* 1. *cap.* 21.

2. Relation of Numbers in Quantity, is the Reference or Reſpect that the Numbers themſelves have to one another, where the Terms or Numbers propounded are always two, the firſt called the Antecedent, and the other the Conſequent. *See* Wing. *Arithm.*

3. The Relation of Numbers in Quantity conſiſts in the Differences, or in the Rate or Reaſon that is found betwixt the Terms propounded, the Difference of two Numbers being the Remainder found by Subtraction (according to *Alſted*) but the Rate or Reaſon betwixt two Numbers is the Quotient of the Antecedent divided by the Conſequent; ſo 21 and 7 being given, the Difference betwixt them will be found to be 14, but the Rate or Reaſon that is betwixt 21 and 7 will be found to be triple Reaſon, for 21 divided by 7 quotes 3, the Reaſon or Rate.

4. The

4. The Relation of Numbers in Quality (otherwiſe called Proportion) is the Reference or Reſpect that the Reaſon of Numbers have one unto another; therefore the Terms given ought to be more than two. Now this Proportion or Reaſon between Numbers relating one to another, is either Arithmetical or Geometrical.

5. Arithmetical Proportion is, when diverſe Numbers differ one from another by equal Reaſon, that is, have equal Differences, (by ſome called Progreſſion.)

So this Rank of Numbers, 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reaſon, *viz.* by 2, as you may prove.

6. In a Rank of Numbers that differ by Arithmetical Proportion, the Sum of the firſt and laſt Term being multiplied by half the Number of Terms, the Product is the total Sum of all the Terms

Or, if you multiply the Numb. r of Terms by the half Sum of the firſt and laſt Terms, the Product is the total Sum of all their Terms.

So in the former Progreſſion given, 3 and 17 is 20, which multiplied by 4, *viz.* half the Number of Terms, the Product gives 80, the Sum of all the Terms: Or multiply 8 (the Number of Terms) by 10, half the Sum of the firſt and laſt Terms; the Product gives 80 as before.

So alſo 21, 18, 15, 12, 9, 6, 3, being given, the Sum of all the Terms will be found to be 84; for here the Number of Terms is 7, and the Sum of the firſt and laſt, (*viz.* 21 and 3) is 24, half whereof (*viz.* 12) multiplied by 7, produceth 84, the Sum of the Terms ſought.

7. Three Numbers that differ by Arithmetical Proportion, the Double of the Mean (or middle Number) is equal to the Sum of the Extremes:

So 9, 12 and 15 being given, the Double of the Mean 12 (*viz.* 24) is equal to the Sum of the two Extremes, 9 and 15.

8. Four Numbers that differ by Arithmetical Proportion (either continued or interrupted) the Sum of the two Means is equal to the Sum of the two Extremes.

So 9, 12, 18, 21, being given, the Sum of 12 and 18 will be equal to the Sum of 9 and 21, *viz.* 30: Alſo, 6, 8, 14, 16, being given, the Sum of 8 and 14 is equal to the Sum of 6 and 16, *viz.* 22, *&c.* *See* Wingate's *Arith.* r. 35.

9. Geometrical Proportion (by ſome called Geometrical Progreſſion) is when diverſe Numbers differ, according to like Reaſon.

So 1, 2, 4, 8, 16, 32, 64, *&c.* differ by double Reaſon, and 3, 9, 27, 81, 243, 729, differ by triple Reaſon; 4, 16, 64, 256, *&c.* differ by quadruple Reaſon, *&c.*

10. In

10. In any Numbers that increase by Geometrical Proportion, if you multiply the last Term by the Quotient of any one of the Terms divided by another of the Terms which being less is next unto it, and having deducted or subtracted the first Term out of that Product, divide the Remainder by a Number that is an Unit less than the said Quotient, the last Quote will be the Sum of all the Terms.

So 1, 2, 4, 8, 16, 32, 64, being given, first I take one of the Terms, *viz.* 8, and divide it by the Term which is less, and next to it (*viz.* by 4) and the Quotient is 2, by which I multiply the last Term 64, and the Product is 128, from whence I subtract the first Term (*viz.* 1) the Remainder is 127, which divided by the Quotient 2 made less by 1, *viz.* 1, the Quote is 127, for the Sum of all the given Terms, as by the Work in the Margent.

64
4) 8 (2
128
1
1) 127 (127

So if 4, 16, 64, 256, 1024, were given the Sum of all the Terms will be found to be 1364. For first I divide 64, one of the Terms, by the next lesser Term, and the Quotient is 4, by which I multiply the last Term 2024, and it produceth 4096; from whence I subtract the first Term 4, and the Remainder is 4092, which I divide by the Quote less by 1, *viz.* 3, and the Quote is 1364, for the total Sum of all the Terms, as *per* Margent.

1024
16) 64 (4
4096
4
3)4092 (1364

11. Three Geometrical Proportions given, the Square of the Mean is equal to the Rectangle, or Product of the Extremes.

So 8, 16, 32, being given, the Square of the Mean, *viz.* 16, is 256, which is equal to the Product of the Extremes 8 and 32, for 8 times 32 is equal to 256.

12. Of four Geometrical proportionable Numbers given, the Product of the two Means is equal to the Product of the two Extremes.

So 8, 16, 32, 64, being given, I say, that the Product of the two Means, *viz.* 16 times 32, which is 512, is equal to 8 times 64, the Product of the Extremes.

Also if 3, 9, 21, 63 were given, which are interrupted, I say, 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariseth that precious Gem in Arithmetick, which for the Excellency thereof is called the *Golden Rule*, or *Rule of Three*.

CHAP.

CHAP. X.

The Single Rule of Three Direct.

THE Rule of Three (not undeservedly called the Golden Rule) is that by which we find out a fourth Number in Proportion unto three given Numbers, so as this fourth Number that is sought may bear the same Rate, Reason and Proportion to the third (given) Number as the second doth to the first; from whence it is also called the *Rule of Proportion.*

2. Four Numbers are said to be proportional when the first containeth, or is contained by the second, as often as the third containeth, or is contained by the fourth. *Vide* Wingate's *Arith chap.* 8. *sect.* 4.

So these Numbers are said to be Proportionals, *viz.* 3, 6, 9, 18, for as often as the first Number is contained in the second, so often is the third contained in the fourth, *viz.* twice: Also 9, 3, 15, 5, are said to be Proportionals; for as often as the first Number containeth the second, so often the third Number containeth the fourth, *viz.* 3 times.

3. The Rule of Three is either simple or compound.

4. The simple (or single) Rule of Three consisteth of four Number, that is to say, it hath three Numbers given to find out a fourth; and this is either Direct or Inverse. *Vide* Alsted. *Math. lib* 2. *c.* 13.

5. The single Rule of Three Direct, is when the Proportion of the first Term is to the second, as the third is to the fourth; or when it is required that the Number sought, *viz.* the fourth Number must have the same Proportion to the second, as the third hath to the first.

6. In the Rule of Three, the greatest Difficulty is to discover the Order of the 3 Terms of the Question propounded, *viz.* which is the first, second, and the third; which that you may understand, observe, that of the three given Numbers, two always are of one Kind; and the other is of the same Kind with the proportional Number that is sought; as in this Question, *viz.* If 4 Yards of Cloth cost 12 Shillings, what will 6 Yards cost at that Rate? Here the two Numbers of one Kind are 4 and 6, *viz.* they both signify so many Yards, and 12*s.* is the same Kind with the Number sought, for the Price of 6 Yards is sought.

Again observe, That of the three given Numbers, those two that are of the same Kind, one of them must be the first, and the other the third, and that which is of the

ſame Kind with the Number ſought, muſt be the ſecond Number in the Rule of Three. And that you may know which of the ſaid Numbers to make your firſt, and which your third, know this, that to one of thoſe two Numbers there is always affixed a Demand, and that Number upon which the Demand lieth, muſt always be reckoned the third Number. As in the forementioned Queſtion, the Demand is affixed to the Number 6; for it is demanded, what 6 Yards will coſt, and therefore 6 muſt be the third Number, and 4 (which is of the ſame Denomination or Kind with it) muſt be the firſt, and conſequently the Number 12 muſt be the ſecond; and then the Numbers being placed in the forementioned Order, will ſtand as followeth, *viz.*

Yards	*s.*	*Yards*
4	12	6

7. The next Thing is, to find out the fourth Number in Proportion; which that you may do, multiply the ſecond Number by the third, and divide the Product thereof by the firſt, or (which is all one) multiply the third Term (or Number) by the ſecond, and divide the Product thereof by the firſt, and the Quotient thence ariſing is the 4th Number in a direct Proportion, and is the Number ſought, or Anſwer to the Queſtion, and is of the ſame Denomination that the ſecond Number is of; as thus, let the ſame Queſtion be again repeated, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt?

Having placed my Numbers according the 6th Rule (of this Chapter) foregoing, I multiply the ſecond Number 12, by the third Number 6, and the Product is 72, which Product I divde by the firſt Number 4, and the Quotient thence ariſing is 18, which is the fourth Proportional or Number ſought, *viz*, 18 Shillings, (becauſe the ſecond Number is Shillings) which is the Price of 6 Yards, as was required by the Queſtion. See the Work following.

Yards	*s.*		*Yards*	*s.*
4	12	::	6	18

6

4) 72 (18 Shillings

4

32

32

(0)

Queſt. 2. Another Queſtion may be this, *viz.* If 7 C. of Pepper coſt 21*l.* how much will 16 C. coſt at that Rate?

To reſolve which Queſtion I conſider that (according to the 6th Rule of this Chapter) the Terms or Numbers ought to be placed thus, *viz.* the Demand lying upon 16 C. it muſt be the third Number, and that of the ſame Kind with it muſt be the firſt, *viz.* 7 C.; and 21*l.* (being of the ſame Kind with the Number ſought) muſt be the ſecond Number in this Queſtion; then I proceed according to this 7th Rule, and multiply the ſecond Number by the third, *viz.* 21 by 16, and the Product is 336, which I divide by the firſt Number 7, and the Quotient is 48*l.* which is the Value of 16 C. of Pepper at the Rate of 21*l.* for 7 C. See the Work following.

C.	*l.*	*C.*
7	21	16
	16	
	126	
	21	
7)	336 (48	*l.*
	28	
	56	
	56 *Facit* 48*l.*	
	(0)	

8. If when you have divided the Product of the ſecond and third Numbers by the firſt, any Thing remain after Diviſion is ended, ſuch Remainder may be multiplied by the Parts of the next inferior Denomination, that are equal to an Unit (or Integer) of the ſecond Number in the Queſtion, and the Product thereof divide by the firſt Number in the Queſtion, and the Quotient is of the ſame Denomination with the Parts by which you multiplied the Remainder, and is Part of the fourth Number which is ſought. And furthermore, if any Thing remain after this laſt Diviſion is ended, multiply it by the Parts of the next inferior Denomination, equal to an Unit of the laſt Quotient, and divide the Product by the ſame Diviſor, (*viz.* the firſt Number in the Queſtion, and the Quote is ſtill of the ſame Denomination with your Multiplier; follow this Method until you have reduced your Remainder into the loweſt Denomination, *&c.* An Example or two will make this Rule very plain, which may be the following.

Queſt.

Queſt. 3. If 13 Yards of Velvet, *&c.* coſt 21*l.* what will 27 Yards of the ſame coſt at that Rate?

Having ordered and wrought my Numbers according to the 6th and 7th Rules of this Chapter, I find the Quotient to be 43*l.* and there is a Remainder of 8, ſo that I conclude the Price of 27 Yards to be more than 43*l.* and to the Intent that I may know how much more, I work according to the foregoing Rule, *viz.* I multiply the ſaid Remainder 8 by 20*s.* (becauſe the ſecond Number in the Queſtion was Pounds) and the Product is 160, which divided by the firſt Number, *viz.* 13, it quotes 12, which are 12 Shillings, and there is yet a Remainder of 4, which I multiply by 12 Pence, (becauſe the laſt Quotient was Shillings) and the Product is 48, which I divide by 13 (the firſt Number) and the Quotient is 3*d.* and yet there remaineth 9, which I multiply by 4 Farthings, and the Product is 36, which divided by 13 again, it quotes 2 Farthings, and there is yet a Remainder of 10, which (becauſe it cometh not to the Value of a Farthing) may be neglected, or rather ſet after the 2 Farthings over the Diviſor with a Line between them, and then (by the 21ſt and 22d Definitions of the firſt Chapter of this Book) it will be $\frac{10}{13}$ of a Farthing; ſo that I conclude, that if 13 Yards of Velvet coſt 21 *l.* 27 Yards of the ſame will coſt 43 *l.* 12 *s.* 3 *d.* $2\frac{10}{13}$ *grs.* which Fraction is 10 Thirteenths of a Farthing. See the Operation as followeth.

	yds.	l.	yds.
If	13	21	27

27

147
42

13) 567 (43 *l.*
52

47
39

Remain (8)
Multiply 20

13) 160 (12 *s.*
13

30
26

Remains (4)
Multiply 12

13) 48 (3 *d.*
39

Remain (9)
Multiply 4

qrs.
13) 36 (2 9/13
26

Remain 10 *Facit*	*l.* 43	*s.* 12	*d.* 3	*qrs.* 2 9/13

Quest. 4. Another Example may be this following, viz. If 14 Pounds of Tobacco cost 27 *s.* what will 478 Pounds cost at that Rate?

Work

Work according to the laſt Rule, and you will find it to amount to 921*s.* 10*d.* $1\frac{2}{14}$*qrs.* and by the 5th Rule of the 8th Chapter 921*s.* may be reduced to 46*l.* 1*s.* ſo that then the whole Worth or Value of the 478 *l.* will be 46*l.* 1*s.* 10*d.* $1\frac{2}{14}$*qrs.* The Work followeth.

l. *s.* *l.*
If 14 : 27 : : 478
27

3346
956

2|0
14)12906(92|1(46*l.*
126 8

30 12
28 12

26 (1)
14

Remains (12)
Multiply 12

24
12

14) 144 (10*d.*
14

Remains (4)
Multiply 4

14) 16 ($1\frac{2}{14}$
Remains (2)

Facit. 46*l.* 1*s.* 10*d.* $1\frac{2}{14}$.

. In the Rule of Three it many times happens, that al-' the first and third Numbers be of one Kind, as both oney, Weight, Measure, *&c.* yet they may not be of one nomination, or perhaps they may both consist of many enominations; in which Case you are to reduce both umbers to one Denomination, and likewise your second umber (if it consisteth at any time of diverse Denomi-tions) must be reduced to the least Name mentioned, or wer if you please; which being done, multiply the se-nd and third together, and divide by the first, as is di-cted in the 7th Rule of this Chapter.

And note, that always the Answer to the Question is in e same Denomination that your second Number is of, is reduced to, as was hinted before.

Quest. 5. If 15 Ounces of Silver be worth 3*l.* 15*s* what e 86 Ounces worth at that Rate?

In this Question the Numbers being ordered according the 6th Rule of this Chapter, the first and third Num-rs are Ounces, and the second Number is of diverse enominations, *viz.* 3*l.* 15*s.* which must be reduced to hillings, and the Shillings multiplied by the third Num-r, and the Product divided by the first, gives you the nswer in Shillings, *viz.* 430 Shillings, which are reduced 21*l.* 10*s.*

oz.	*l.*	*s.*		*oz.*
If 15	: 3	15	: :	86
	20			
	75			
	86			
	450			
	600			
	20		*l.*	*s.*
15)	6450	(430	(21	10
	60	4		
	45	3		
	45	2		
	(0)	(10) *s.*		

In resolving the last Question, the Work would have been the same if you had reduced your second Number into Pence, for then the Answer would have been 5160 Pence, equal to 21*l.* 10*s.* or if you had reduced the second Number into Farthings, the Quotient or Answer would have been 20640 Farthings, equal to the same, as you may prove at your Leisure.

Quest.

Queſt. 6. If 8 lb of Pepper coſt 4*s.* 8*d.* what will 7 *C.* 3*qrs.* 14 lb coſt?

In this Queſtion the firſt Number is 8lb and the third is 7*C.* 3*qrs.* 14lb which muſt be reduced to the ſame Denomination with the firſt, *viz.* into Pounds and the ſecond Number muſt be reduced into Pence; then multiply and divide according to the 7th Rule foregoing, and you will find the Anſwer to be 6174 Pence, which is reduced into 25*l.* 14*s.* 6*d.*

lb *s.* *d.* *C.* *qrs.* lb

If 8 coſt 4 8 what will 7 3 14 coſt?

12 4

56 31

28

252

63

882

56 ſecond Number

5292

4410

8) 49392 (6174

48

13

8

59

56

32

32

(0)

12) 2|0) *l.* *s.* *d.*

(51|4 (25 14 6

60 4

17 11

12 10

54 (14)*s.*

48

(6)*d.*

l. *s.* *d.*

Facit 25 14 6

Queſt.

Queſt. 7. If 3*C.* 1*qr.* 14*lb* of Raiſins coſt 9*l.* 9*s.* what will 6*C.* 3*qrs.* 20*lb* of the ſame coſt?

Here the firſt and third Numbers each conſiſt of diverſe Denominations, but muſt be brought both into one Denomination, *&c.* as you ſee in the Operation that followeth.

If 3 1 14 coſt 9*l.* 9*s.* what will 6 3 20 coſt?

4		20			4					
13		189			27					
28					28					
108					216					
27					56					
378 Pounds					776 Pounds					
					189 ſecond Number					
					6984					
					6208					
					776					
						2|0	*l.*	*s.*		
			378)	146664	(38|8	19	8			
				1134	2					
				3326	18					
				3024	18					
				3024	(8)					
		l.	*s.*	3024						
	Facit	19	8							
				(0)						

Queſt. 8 If in 4 Weeks I ſpend 13*l.* 4*d.* how long will 3*l.* 6*s.* laſt me at that Rate?

Anſwer 2238 Days, equal to 6 Years, 48 Days. See the Work.

s. *d.* *W.* *l.* *s.*

If 13 4 require 4 what will 53 6 require ?

12 7 20

30 28 Days 1066

13 12

160 2132

1066

12792 Pence

28 ſecond Number

102336

25584

365

16|0) 35817|6 (2238 (6 Years

2190

32

Rem. (48) Days

38

32

61 *Years* *Days*

48 *Facit* 6 $48\frac{96}{160}$

137

128

Remains (96)

Queſt. 9. Suppoſe the yearly Rent of a Houſe, a year Penſion, or Wages, be 73*l.* I deſire to know how muc it is *per* Day ?

Here you are to bring the Year into Days, and ſay, 365 Days require 73*l.* what will one Day require ?

Now when you come to multiply 73 by 1, the Produ is the ſame, for 1 neither multiplieth nor divideth ; an 73 cannot be divided by 365, becauſe the Diviſor is bi ger than the Dividend ; wherefore bring the 73*l.* into Shi lings, and they make 1460, which divide by the fir Number, 365, and the Quote is 4 Shillings for the An ſwer ; as you ſee in the Work. *De*

Days	*l.*	*Day*
If 365	73	1
	20	
365)	1460 (4 *s.*	
	1460	
	----	*Facit 4 s. per Day.*

(o)

Queſt. 10. A Merchant bought 14 Pieces of Broad-cloth, each Piece containing 28 Yards, for which he gave after the Rate of 13*s.* 6*d.* ½ *per* Yard, now I deſire to know how much he gave for the 84 Pieces at that Rate?

Firſt find out how many Yards are in the 14 Pieces, which you will do if you multiply the 14 Pieces by 28 (the Number of Yards in a Piece) and it makes 392; then ſay, if 1 Yard coſt 13*s.* 6*d.* ½ what will 392 Yards coſt? Work as followeth, and the Anſwer you will find to be 127400 Half-pence, which reduced makes 265*l.* 8*s.* 4*d.* for after you have multiplied your ſecond and third Numbers together, the Product is 127400, which (according to the ſeventh Rule) ſhould be divided by the firſt Number; but the firſt Number is 1, which neither multiplieth nor divideth, and therefore the Quotient, or fourth Number, is the ſame with the Product of the ſecond and third, which is in Half-pence, becauſe the ſecond Number was ſo reduced. See the Work as followeth.

28
14
112
28
392 Yards in the 14 Pieces.

Yd.	*s.*	*d.*		*Yds.*	
If 1 coſt	13	6½,	what will	392	coſt?
	12			325	the ſecond Number.
	32		(o)	1960	
	13			784	
	162			1176	
	2			----	20
Half-pence	325		24)	127400 (5308	(265 *l.*
				120	4
				74	13
				72	12
				200	10
Facit 265*l.* 8*s.* 4*d.*				192	10
			Remains	(8)	(8) Shillings.
			Half-pence, or 4*d.*		

Queſt.

Queſt. 11. A Draper bought 420 Yards of Broad-cloth, and gave for it after the Rate of 14*s.* 10*d.* ¾ *per* Ell *Engliſh*, now I demand how much he paid for the Whole after that Rate?

Bring your Ells into Quarters, and your given Yards into Quarters; the Ell is 5 Quarters, and in 420 Yards are 1680 Quarters; then ſay, if 5 Quarters coſt 14*s.* 10*d.* ¾ (or 715 Farthings) what will 1680 Quarters coſt? *Facit* 250*l.* 5*s.* See the Operation.

Ells	*Yards.*
1	420
5	4
5	1680

qrs.	*s.*	*d.*		
If 5	: 14	10 ¾	: :	1680
	12			715
	28			8400
	15			1680
	178 *d.*			11760
	4			9610
	715 *qrs.*			5) 12012 00 (2402 40 (250*l.*

	20	192
	20	482
	12	480
	20	Rem. (240) *qrs.* or 5*l.*
	20	
	(0)	

l.	*s.*	*d.*
Facit 250	5	0

Queſt. 12. A Draper bought of a Merchant 50 Pieces of Kerſey, each Piece containing 34 Ells *Flemiſh* (the Ell *Flemiſh* being three Quarters of a Yard) to pay after the Rate of 8*s.* 4*d. per* Ell *Engliſh*; I demand how much the 50 Pieces coſt him at that Rate?

Firſt find out how many Ells *Flemiſh* are in the 50 Pieces by multiplying 50 by 34, the Product is 1700, which bring into Quarters by 3, it makes 5100 Quarters; then proceed as in the laſt Queſtion, and the Anſwer you will find to be 102000 Pence, or 425*l.* See the Operation as followeth.

If

qrs.	s.	d.	qrs.		
If 5	: 8	4	: : 5100		50
	12		100		34
			d.		
100 d.			5) 3400000 (102000		200
					150
		5			
					1700 Ells Fl.
		10			3
		10			
					5100
		(0)	(2|0		
		12) 102000 (850|0		(425 l.	
		96	8		
		60	5		
		60	4		
		(0)	10		
			10		
Facit 425 l.			(0)		

Queſt. 13. A Goldſmith bought a Wedge of Gold which weighed 14 lb 3 oz. 8 *pwt.* for the Sum of 514 *l.* 4 *s.* I demand what it ſtood him in *per* Ounce? *Anſwer* 60 *s.* or 3 *l.*

lb	oz.	pwt.		l.	s.	oz.
If 14	3	8	:	514	4	: : 1
12				20 Shil.		20
31				10284		20 *pwt.*
14				20 *pwt.*		
171 oz.				2|0)		
20				3428) 205680 (6|0 (3 l.		
				6		
3428 *pwt.*				205680		
				(0) Facit. 60 *s.* or 3 *l.*		
				(0)		

Queſt.

Queſt, 14. A Grocer bought 4 Hogſheads of Sugar, each weighing neat 6 *C.* 2 *qrs.* 14 lb which coſt him 2*l.* 8*s.* 6*d. per C.* I demand the Value of the 4 Hhds, at that Rate?

Firſt find the Weight of the 4 Hhds, which you may do by reducing the Weight of one of them into Pounds, and multiply them by 4 (the Number of Hhds) and they make 2968 lb: then ſay, if 1 *C.* or 112 lb coſt 2*l.* 8*s.* 6*d.* what will 2968 lb coſt? *Facit* 64*l.* 5*s.* 3*d.* as by the Operation.

lb	*l.*	*s.*	*d.*		lb			*C.*	*qrs.*	lb
								6	2	14
								4		
								26		
								28		
If 112	2	8	6	::	2968			212		
	20				582			53		
	48				5936			4 hogſheads		
	12				23744					
	102				14840			2968 lb in 4 hhds.		
	48				112) 1727376 (15423			12) 2|0 (128|5		(64*l.*
	582				112			12		12
					607			34		8
					560			24		8
					473			102		(5) Shillings
					448			96		
					257			63		
					224			60		
					336			(3) Pence		
					336					
					(0)			*Facit* 64*l.* 5*s.* 3*d.*		

Quest. 15. A Draper bought of a Merchant 8 Packs of th, each containing 4 Parcels, and each Parcel 10 Pieces, d each Piece 26 Yards, and gave after the Rate of 4*l.* . for 6 Yards, now I desire to know how much he gave the Whole? *Answer* 6656*l.*

First find out how many Yards there were in the 8 Packs, d by the following Work you will find there are 8320 rds: then say, if 6 Yards cost 4*l.* 16*s.* what will 8320 rds cost, *&c.*

8 Packs
4
32 Parcels
10
320
26
1920
640
8320 Yards

Yds.	*l.*	*s.*	*Yds.*
6	4	16	8320
20			96
96			49920
			74880
			210

6) 798720 (133120 (6656 *l.*
6 12
19 13
18 12
18 11
18 10
7 12
6 12
12 (0)
12
(0)

cit 6656*l.*

By this time the Learner is, as I suppose, well exercised the Practick and Theorick of the *Rule of Three Direct*; t at his Leisure he may look over the following Questis, whose Answers are given, but the Operation purposely nitted as a Touchstone for the Learner, thereby to try s Ability in what hath been deliver'd in the former Rules.

Quest. 16. If 24*l.* of Raisins cost 6*s.* 6*d.* what will 18 Frails ft, each weighing neat 3*qrs* 18*lb.* *Answer* 24*l.* 17*s.* 3*d.*

Quest. 17. If an Ounce of Silver be worth 5 Shillings, hat is the Price of 14 Ingots, each Ingot weighing 7*lb.* . 10*pwt.* *Answer* 313*l.* 5*s.*

Quest.

Queſt. 18. If a Piece of Cloth coſt 10*l.* 16*s.* 8*d.* I dema how many Ells *Engliſh* there are in the ſame, when Ell at that Rate is worth 8*s.* 4*d.*? *Anſwer* 26 Ells *Engl*

Queſt. 19. A Factor bought 84 Pieces of Stuffs, wh coſt him in all 537*l.* 12*s.* at 5*s.* 4*d. per* Yard, I dema how many Yards there were in all, and how many *Engliſh* were contained in a Piece of the ſame? *Anſw* 2016 Yards in all, and 19$\frac{1}{2}$ Ells *Engliſh per* Piece.

Queſt. 20. A Draper bought 242 Yards of Broad-clo which coſt him in all 254*l.* 10*s.* for 86 Yards of wh he gave after the Rate of 21*s.* 4*d. per* Yard. I dema how much he gave *per* Yard for the Remainder? *Anſ* 20*s.* 10*d.* $\frac{6}{7}\frac{3}{5}$ *per* Yard.

Queſt. 21. A Factor bought a certain Quantity of Ser and Shalloon, which together coſt him 26*l.* 14*s.* 10*d.* T Quantity of Serge he bought was 48 Yards, at 4*s.* 4*d.* Yard; and for every two Yards of Serge he had 5 Ya of Shalloon; I demand how many Yards of Shalloon had, and how much the Shalloon coſt him *per* Yard?

Anſ. 120 Yards of Shalloon at 2*s.* 8*d.* $\frac{3}{8}\frac{1}{0}$ *per* Yard?

Queſt. 22. An Oilman bought three Tuns of Oil, wh coſt him 151*l.* 14*s.* and ſo it chanced that it leaked out Gallons; but he is minded to ſell it again, ſo that he m be no Loſer by it; I demand how he muſt ſell it *per* G lon? *Anſwer*, at 4*s.* 6*d.* $\frac{1}{7}\frac{7}{3}\frac{3}{2}$*d. per* Gallon.

Queſt. 23. Bought 6 Packs of Cloth, each Pack conta ing 12 Cloths, which at 8*s.* 4*d. per* Ell *Flemiſh*, coſt 10 I demand how many Yards there were in each Cloth *Anſwer*, 27 Yards in each Cloth?

Queſt. 24. A Gentleman hath 536*l. per Ann.* and his E pences are, one Day with another 18*s.* 10*d.* 3*qrs.* I de to know how much he layeth up at the Year's End? *A ſwer* 191*l.* 3*s.* 0*d.* 1*qr.*

Queſt. 25. A Gentleman expendeth daily one Day w another 27*s.* 10*d.* $\frac{1}{2}$, and at the Year's End layeth 340*l.* I demand how much is his yearly Income? *Anſ* 848*l.* 14*s.* 4*d.*

Queſt. 26. If I ſell 14 Yards for 10*l.* 10*s.* how m Ells *Flemiſh* ſhall I ſell for 283*l.* 17*s.* 6*d.* at that Rate? *A ſwer* 504$\frac{1}{2}$ Ells *Flemiſh.*

Queſt. 27. If 100*l.* in 12 Months, gain 6*l.* Inter how much will 75*l.* gain in the ſame Time, and at ſame Rate? *Anſwer* 4*l.* 10*s.*

Queſt. 28. If 100*l.* in 12 Months, gain 6*l.* Intereſt, how much will it gain in 7 Months at that Rate? *Anſw.* 3*l.* 10*s.*

Queſt. 29. A certain Uſurer put out 75*l.* for 12 Months, and received Principal and Intereſt 81*l.* I demand at what Rate *per Cent.* he received Intereſt? *Anſwer* 8*l. per Cent.*

Queſt. 30. A Grocer bought 2 Cheſts of Sugar, the one weigh'd neat 18*C.* 3*qrs.* 14*lb* at 2*l.* 6*s.* 8*d. per C.* the other weigh'd neat 18*C.* 1*qr.* 21*lb* at 4*d.* $\frac{1}{2}$ *per lb* which he mingled together; now I deſire to know how much a *C.wt.* of this Mixture is worth? *Anſwer* 2*l.* 4*s.* 4*d.* $1\frac{1}{4}\frac{198}{784}$*qrs.*

Queſt. 31. Two Men, *viz. A* and *B* departed both from one Place, the one goes *Eaſt*, and the other *Weſt*; one travelleth 4 Miles a Day, and the other 5 Miles a Day, how far are they diſtant, the 9th Day after their Departure? *Anſwer* 81 Miles.

Queſt. 32. *A*, flying every Day 40 Miles, is purſued the fourth Day after by *B*, poſting 50 Miles a Day? Now the Queſtion is, in how many Days, and after how many Miles Travel will *A* be overtaken?

Anſw. B overtakes him in 12 Days, when they have travelled 600 Miles. See *More's* Arithm. cap. 8. qu 7.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the ſame, that is, to find a fourth Number in Proportion, conſiſting of two equal Reaſons; as hath been fully ſhewn in all the foregoing Examples.

The ſecond Effect is, by the Price or Value of one Thing, to find the Price and Value of many Things of like Kind.

The third Effect is, by the Price or Value of many Things, to find the Price of one; or by the Price of many Things, (the ſaid Price being one) to find the Price of many Things of like Kind.

The fourth Effect is, by the Price or Value of many Things, to find the Price or Value of many Things of like Kind.

The fifth Effect is, thereby to reduce any Number of Moneys, Weights, or Meaſures, the one Sort into the other, as in the Rules of Reduction contained in the eighth Chapter foregoing. Examples of its various Effects have been already anſwered.

12. The Rule of Three Direct is thus proved, *viz.* multiply the firſt Number by the fourth, and note the Product; then multiply the ſecond Number by the third, and if this Product is equal to the Product of the firſt and fourth, then the Work is rightly performed, otherwiſe it is erroneous. *The Proof of the Rule of Three Direct.*

So the first Question of this Chapter, (whose Answer or fourth Number we found to be 18*s*.) is thus proved, *viz.* the first Number is 4, which multiplied by 18 (the fourth) produceth 72, and the second and third Numbers are 12 and 16, which multiplied together produce 72, equal to the Product of the first and fourth, and therefore I conclude the Work to be rightly performed.

Always observing, that if any Thing remain after you have divided the Product of the second and third Numbers by the first, such Remainder in proving the same must be added to the Product of the first and fourth Numbers, whose Sum will be equal to the product of the second and third, the second Number being of the same Denomination with the fourth, and the first of the same Denomination with the third.

So the fourth Question of this Chapter being again repeated, *viz.* if 14 ℔ of Tobacco cost 27*s*. what will 478 ℔ cost at that Rate? The Answer (or fourth Number) was 46*l*. 1*s*. 10*d*. 1*qr*. $\frac{2}{14}$, which is thus proved, *viz.* bring the fourth Number into Farthings, and it makes 44249, which multiplied by the first Number 14, produceth 619488 (the second which remaineth being added thereto); then, because I reduce my fourth Number into Farthings, I reduce may second (*viz.* 27*s*.) into Farthings, and they are 1296, which multiplied by the third Number 478, their Product is 619488, equal to the product of the first and fourth Numbers, wherefore I conclude the Operation to be true. This is an infalliable Way to prove the Rule of Three Direct, and it is deduced from the 12th Section of the 9th Chapter of this Book.

And thus much for this inestimable Rule of Three Direct, the Demonstration of which may be seen in *Kersey*'s Appendix to *Wingate*'s Arithmetick, and in the 6th Chapter of *Oughtred's Clavis Mathematicæ*.

CHAP. XI.

The Single Rule of Three Inverse.

1. THE Golden Rule, or Rule of Three Inverse, is when there are three Numbers given, to find a fourth in such proportion to the three given Numbers, to as the fourth proceeds from the second, according to the same Rate, Reason or proportion, that the first proceeds from the third, or the proportion is.

A

As the third Number is in proportion to the ſecond, ſo is the firſt to the fourth. See *Alſted. Math.* l. 2. c. 14.

So if the three given Numbers were 8, 12 and 16, and it were required to find a fourth Number in an inverted proportion to theſe, I ſay, that as 16 (the third Number) is the Double of the firſt Term or Number (8) ſo muſt 12, the ſecond Number, be the Double of the fourth; ſo will you find the fourth Term or Number to be 6. And (as in the Rule of Three Direct) you multiply the ſecond and third together, and divide their Product for a fourth proportional Number.

2. In the Rule of Three Inverſe, you muſt multiply the ſecond Term by the firſt, or firſt Term by the ſecond, and divide the Product thereof by the third Term, ſo the Quotient will give you the fourth Term ſought in an inverted Proportion. The ſame Order being obſerved in this Rule as in the Rule of Three Direct, for placing and diſpoſing of the given Numbers, and after your Numbers are placed in Order, that you may know whether your Queſtion be to be reſolved by the Rule Direct or Inverſe, obſerve the general Rule following.

3. When your Queſtion is ſtated, and your Numbers orderly diſpoſed, conſider in the firſt Place whether the fourth Term or Number ſought ought to be more or leſs than the ſecond Term, which you may eaſily do; and if it is required to be more or greater than the ſecond Term, then the leſſer Extreme muſt be your Diviſor; but if it requires leſs, then the higheſt Extreme muſt be your Diviſor; in this Caſe the firſt and third Numbers are called Extremes (in reſpect of the ſecond) and having found out your Diviſor, you may know whether your Queſtion belong to the Rule Direct or Inverſe; for if the third Term be your Diviſor, then it is Inverſe, but if the firſt Term be your Diviſor, then it is a Direct Rule: As in the following Queſtions.

Queſt. 1. If 8 Labourers can do a certain piece of Work in 12 Days, in how many Days will 16 Labourers do the ſame? *Anſwer*, in 6 Days.

Having placed the Numbers according to the 6th Rule of the 10th Chapter, I conſider, that if 8 Men can finiſh the Work in 12 Days, 16 Men will do it in leſſer (or fewer Days) than 12, therefore the bigger Extreme muſt be the Diviſor, which is 16, and therefore it is the Rule of Three Inverſe; wherefore I multiply the firſt and ſecond Numbers together, *viz.* 8 by 12,

Lab.	*Days*	*Lab.*
8	12	16

8

16) 96 (6 Days

96

(0)

Facit 6 Days.

12 the Product is 96, which divided by 16 the third Term quotes 6 Days for the Answer: and in so many Days 16 Labourers perform a piece of Work, when 8 Men can do it in 12 Days.

Quest. 2. If when the Measure, *viz.* (a Peck) of Wheat cost 2*s.* the Penny Loaf weighed (according to the Standard, Statute or Law of *England*) 8 Ounces, I demand how much it will weigh when the Peck is worth 1*s.* 6*d.* according to the same Rate or proportion? *Answ.* 10 *oz.* 13 *pwt.* 8 *gr.*

Having placed and reduced the given Numbers according to the 6th and 9th Rules of the 10th Chapter, I consider that at 1*s.* 6*d. per* Peck, the Penny Loaf will weigh more than at 2*s. per* Peck; for as the Price decreaseth, the Weight increaseth; and as the Price increaseth, so the Weight diminishes; wherefore, because the first Term requires more than the second, the lesser Extreme must be the Divisor, *viz.* 1*s.* 6*d.* or 18*d.* and having finished the Work, I find the Answer to be 10*oz.* 13*pwt.* 8*gr.* and so much will the Penny Loaf weigh when the Peck of Wheat is worth 1*s.* 6*d.* according to the given Rate of 8 Ounces when the Peck is worth 2*s.* The Work is plain in the following Operation:

d.	*oz.*	*dr.*
If 24	8	18
8		

oz. pwt. gr.

18) 192 (10 13 8 *Answ.*
18

12
20

pwt.

240 (13
18

60
54

6)
24

144 (8 *gr.*
144

(0)

Queſt. 3. How many Pieces of Money or Merchandize, at 20 *s.* per Piece, are to be given or received for 240 Pieces, the Value or Price of every Piece being 12 Shillings? *Anſ.* 144 Pieces. For if 12 *s.* required 240 Pieces, then 20 *s.* will require leſs; therefore the bigger Extreme muſt be the Diviſor, which is the third Number, *&c.* See the Work as in the Margent.

s.	*pcs.*	*s.*
If 12	240	20
	12	
	480	
	240	
20)	2880	(144 *pcs.* at 20 *s. per* pc.
	2	
	8	
	8	
	8	
	8	
	(0)	

Queſt. 4. How many Yards of 3 Quarters broad are required to double or be equal in Meaſure to 30 Yards that are 5 Quarters broad? *Anſwer*, 50 Yards. For ſay, if 5 Quarters will require 30 Yards long, what Length will 3 Quarters broad require? Here I conſider that 3 Quarters broad will require more Yards than 30; for the narrower the Cloth is, the more in Length will go to make equal Meaſure with a broader Piece.

qrs	*long*	*qrs.*
5	30	3
	5	
3)	150	(50 *Yards*
	15	
	(0)	

Queſt. 5. At the Requeſt of a Friend I lent him 200*l.* for 12 Months, promiſing to do me the like Courteſy at my Neceſſity; but when I came to requeſt it of him, he could let me have but 150*l.* now I deſire to know how long I may keep this Money to make plenary Satisfaction for my former Kindneſs to my Friend? *Anſ.* 16 Months. I ſay, if 200*l.* require 12 Months, what will 150*l* require. 150*l.* will require more Time than 12 Months, therefore the leſſer Extreme (*viz.* 150) muſt be the Diviſor; multiply and divide, and you will find the fourth inverted Proportional to be 16, and ſo many Months I ought to keep the 150*l.* for Satisfaction.

Queſt 6. If for 24 *s.* I have 1200 lb Weight carried 36 Miles, how many Miles ſhall 1800 lb be carried for the ſame Money? *Anſ.* 24 Miles.

Queſt. 7. If for 24 *s.* I have 1200 lb Weight carried 36 Miles, how many lb Weight ſhall I have carried 24 Miles for the ſame Money? *Anſ.* 1800 lb Weight.

Queſt.

Quæſt. 8. If 100 Workmen in 12 Days finiſh a Piece of Work or Service, how many Workmen are ſufficient to do the ſame in 3 Days? *Anſwer*, 400 Workmen.

Queſt. 9. A Colonel is beſieged in a Town, in which are 1000 Soldiers, with Proviſion of Victuals only for 3 Months; the Queſtion is, how many of his Soldiers muſt he diſmiſs that his Victuals may laſt the remaining Soldiers 6 Months? *Anſwer* 500 he muſt keep, and diſmiſs as many.

Queſt. 10. If 20*l.* worth of Wine is ſufficient for the Ordinary of 100 Men, when the Tun is ſold for 30*l.* how many Men will the ſame 20*l.* worth ſuffice, when the Tun is worth 24*l.*? *Anſwer* 125 Men.

Queſt. 11. How much Pluſh is ſufficient for the Cloak which hath in it 4 Yards of 7 Quarters wide, when the Pluſh is but 3 Quarters wide? *Anſw.* $9\frac{1}{3}$ Yards of Pluſh.

Queſt. 12. How many Yards of Canvas, that is Ell wide, will be ſufficient to line 20 Yards of Say, that is 3 Quarters wide? *Anſwer* 12 Yards.

Queſt. 13. How many Yards of Mattin that is 2 Foot wide, will cover a Floor that is 24 Foot long and 20 Foot broad? *Anſwer* 80 Yards.

Queſt. 14. A Regiment of Soldiers conſiſteth of 1000, are to have new Coats, and each Coat to contain two Yards two Quarters of Cloth that is 5 Quarters wide, and they are to be lined with Shalloon that is 3 Quarters wide, I demand how many Yards of Shalloon will line them? *Anſwer* $16666\frac{2}{3}$ Quarters, or $4166\frac{2}{3}$ Yards.

Queſt. 15. A Meſſenger makes a Journey in 24 Days, when the Days are 12 Hours long; I deſire to know in how many days he will go the ſame, when the Day is 16 Hours long? *Anſwer* in 18 Days.

Queſt. 16. I borrowed of my Friend 64*l.* for 8 Months, and he hath Occaſion another Time to borrow of me for 12 Months I deſire to know how much I muſt lend to make good his former Kindneſs to me? *Anſwer* 42*l.* 13*s.* 4*d.*

4. The general Effect of the Rule of Three Inverſe, is contained in the Definition of the ſame, that is, to find a fourth Term in a reciprocal Proportion inverted to the Proportion given.

The ſecond Effect is, by two Pieces, or Value of two ſeveral Pieces of Money and Merchandize known, to find how many Pieces of the one Price is to be given for ſo many of the other; and ſo to reduce and exchange one Sort of Money or Merchandize into another. Or elſe to find the Price unknown of any Price given to exchange in reciprocal Proportion.

The

The third Effect is, by two different Prices of a Meaſure of Wheat bought or ſold, and the Weight of a Loaf of Bread, made anſwerable to one of the Prices of the Meaſure given, to find out the Weight of the ſame Loaf anſwerable to the other Price of the ſaid Meaſure given.

Or elſe, by the two ſeveral Weights of the ſame priced Loaf, and the Price of the Meaſure of Wheat anſwerable to one of thoſe Weights given, to find out the other Price of the Meaſure anſwerable to the other Weight of the ſame Loaf.

The fourth Effect is, by two Lengths and one Breadth of two rectangular Planes known, to find out another Breadth unknown. Or, by two Breadths and one Length given, to find out another Length unknown in an inverted Proportion.

The fifth Effect is, by a double Time and a capital Sum of Money borrowed or lent, to find out another capital Sum anſwerable to one of the given Times; or otherwiſe, by two capital Sums, and a Time anſwerable to one of them given, to find out a Time anſwerable to the other capital Sum in reciprocal Reaſon.

The ſixth Effect is, by two different Weights of Carriage, and the Diſtance of the Place in Leagues or Miles given, to find another Diſtance in Miles anſwerable to the ſame Price of Payment. Or otherwiſe, by two Diſtances in Miles, and the Weight anſwerable to one of the Diſtances (being carried for a certain Price) to find out the Weight anſwerable to the other Diſtance for the ſame Price.

The ſeventh Effect is, by double Workmen, and the Time anſwerable to one of the Numbers of Workmen given, to find out the Time anſwerable to the other Number of Workmen, in the Performance of any Work or Service. Or contrarywiſe, by double Time, and the Workmen anſwerable to one of thoſe Times given, to find out the Number of Workmen anſwerable to the other Time, in the Performance of any Work or Service.

Alſo by a double Price of Proviſion; and the Number of Men or other Creatures nouriſhed for a certain Time, anſwerable to one of the prices of Proviſion given, to find out another Number of Men or other Creatures anſwerable to the other price of the Proviſion for the ſame Time. Or contrarywiſe, by two Numbers of Men or other Creatures nouriſhed, and one price of Proviſion anſwerable to one of the Numbers of Creatures given, to find out the other price of the ſame Proviſion anſwerable to the other Number of Creatures both being ſuppoſed to be nouriſhed for the ſame, *&c.*

To prove the Operation of the Rule of Three Inverſe, multiply the 3d and 4th Terms together, and note their Product, and multiply the 1ſt and 2d together, and if their Product is equal to the Product of the 3d and 4th, then is the Work truly wrought, but if it falleth out otherwiſe, then it is erroneous.

As in the firſt Queſtion of this Chapter, 16 (the third Number) being multiplied by 6 (the fourth Number) the Product is 96, and the Product of 8 (the firſt Number) multiplied by 12 (the ſecond Number) is 96, equal to the firſt Product, which proves the Work to be right.

And note, That if in Diviſion any Thing remain, ſuch Remainder muſt be added to the Product of the third and fourth Terms, and if the Sum be equal to the Product of the firſt and ſecond) the homogeneal Terms being of one Denomination, the Work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the Rule of ſingle Proportion, and we come now to lay down the Rules of plural Proportion.

1. Plural Proportion is, when more Operations in the Rule of Three than one are required before a Solution can be given to the Queſtion propounded. Therefore in Queſtions that require Plurality in Proportion, there are always given more than three Numbers.

2. When there are given five Numbers, and a ſixth is required in proportion thereunto, then the ſixth Proportion is ſaid to be found out by the Double Rule of Three, as in the Queſtion following, *viz.*

If 100*l.* in 12 Months gain 6*l.* Intereſt, how much will 75*l.* gain in 9 Months?

3. Queſtions in the Double Rule of Three may be reſolved either by two ſingle Rules of Three, or by one ſingle Rule of Three compounded of the five given Numbers.

4. The Double Rule of Three is either Direct or elſe Inverſe

5. The Double Rule of Three Direct is, when unto 5 given Numbers, a 6th Proportional may be found out by two ſingle Rules of Three Direct.

6. The 5 given Numbers in the Double Rule of Three Direct conſiſt of two Parts, *viz.* 1. A Suppoſition, and 2dly, of a Demand: The Suppoſition is contained in the three firſt of the five given Numbers, and the Demand lies in

in the two laſt, as in the Example of the ſecond Rule of this Chapter, *viz.* If 100*l.* in 12 Months gain 6*l.* Intereſt, what will 75*l.* gain in 9 Months? Here the Suppoſition is expreſſed in 100, 12, and 6; for it is ſaid, if 100*l.* in 12 Months gain 6*l.* Intereſt: And the Demand lieth in 75 and 9; for it is demanded, How much 75*l.* will gain in 9 Months.

7. When your Queſtion is ſtated, the next Thing will be to diſpoſe of the given Numbers in due Order and Place, as a preparative for Reſolution; which that you may do, firſt, Obſerve which of the given Numbers in the Suppoſition is of the ſame Denomination with the Number required, for that muſt be the 2d Number (in the firſt Operation) of the Single Rule of Three, and one of the other Numbers in the Suppoſition (it matters not which) muſt be the firſt Number, and that Number in the Demand, which is of the ſame Denomination with the firſt, muſt be the third Number; which three Numbers being thus placed, will make one perfect Queſtion in the Single Rule of Three, as in the forementioned Example; firſt, I conſider, that the Number required in the Queſtion, is in the Intereſt or Gain of 75*l.* therefore that Number in the Suppoſition which hath the ſame Name, *viz.* 6*l.* which is the Intereſt or Gain of 100*l.* muſt be the ſecond Number in the firſt Operation, and either 100 or 12 (it matters not which) muſt be the firſt Number, but I will take 100; and then for the third Number, I put that Number in the Demand which hath the ſame Denomination with 100, which is 75, for they both ſignify Pounds principal, and then the Numbers will ſtand as you ſee in the Margent.

100	6	75

But if I had for the firſt Number put the other Number in the Suppoſition, *viz.* 12, which ſignifies 12 Months, then the third Number muſt have been 9, which is the Number in the Demand which hath the ſame Denomination with the firſt, *viz.* 9 Months, and they will ſtand as in the Margent.

12	6	9

There yet remains two Numbers to be diſpoſed of, and thoſe are one in the Suppoſition, and another in the Demand; that which is of the Suppoſition, I place under the firſt of the three Numbers; and the other, which is the Demand, I place under the third Number; and then two of the Terms in the Suppoſition will ſtand (one over the other) in the firſt place, and the two Terms in the Demand will ſtand (one over the other) in the third place, as in the Margent.

100	7	75
12		9

Or this,

12	6	9
100		75

1. Having diſpoſed or ordered the given Numbers according to the laſt Rule, we may proceed to a Reſolution: And firſt I work with the 3 uppermoſt Numbers, which, according to the firſt Diſpoſition are 100 : 6 : : and 75; which is as much as to ſay, if 100*l.* requires 6*l.* Intereſt, how much will 75*l.* require? Which, by the third Rule of the 11th Chapter, I find to be Direct, and by the 7th and 8th Rules of the 10th Chapter, I find the 4th proportional Number to be 4*l.* 10*s.* ſo that by the foregoing ſingle Queſtion I have diſcovered how much Intereſt 75*l.* will gain in 12 Months; the Operation whereof followeth on the left Hand under the Letter A: And having diſcovered how much it will gain in 12 Months, we may by another Queſtion eaſily diſcover how much it will gain in 9 Months; for this 4th Number (thus found) I put in the Middle between the two loweſt Numbers of the 5, after they are placed according to the 7th Rule of this Chapter, and then it will be a ſecond Number, in another Queſtion of the Rule

M. *l.* *s.* *M.*

of Three. The Numbers being 12 : 4 10 : : 9 the firſt and third Numbers being of one Denomination, *viz.* both Months, and may be thus expreſſed; if 12 Months require 4*l.* 10*s.* Intereſt, what will 9 Months require? And by the third Rule of the 11th Chapter, I find it to be the Direct Rule, and by working according to the Directions laid down in the 7th, 8th and 9th Rules of the 10th Chapter, I find the fourth proportional Number to the laſt ſingle Queſtion to be 3*l.* 7*s.* 6*d.* which is the ſixth proportional Number to the five given Numbers, and is the Anſwer to the general Queſtion. The Work of the laſt ſingle Queſtion is expreſſed on the right Side of the Page, under the Letter B, as followeth.

A

100
12
l. *l.* *l.*
If 100 6 75
75
30
42
100) 450 (4 10
4
Rem. (50)
Mult. 20
100) 1000 (10*s.*
l. *s.*
Facit 4 10

B

---6---75
9
Then say,
M. *l.* *s.* *M.*
If 12 4 10 9
20
90
12
180
90
1080 Pence
9
------12 20 *l.* *s.* *d.*
12)9720(810(67 (3 7 6
96 72 ------
------ ------ 7 *s.*
12 90
12 84
(0) (6) *d.*

Facit 3*l.* 7*s.* 6*d.*

So that by the foregoing Operation I conclude, that if, 100*l.* in 12 Months, gain 6*l.* Intereſt, 75*l.* will gain 3*l.* 7*s.* 6*d.* in 9 Months, after the ſame Rate. The Anſwer would have been the ſame if the given Numbers had been ordered according to the ſecond Method, *viz.* as you ſee in the Margent.

12 6 9
100 75

For firſt, I ſay, if 12 Months gain 6*l.* what will 9 Months gain? This Queſtion I find to be direct, by the 3d Rule of the 11th Chapter, and by the 7th and 8th Rules of the 10th Chapter, I find the fourth proportional Number to theſe three to be 4*l.* 10*s.*

Thus have I found out what is the Intereſt of 100*l.* for 9 Months, and am now to find the Intereſt of 75*l.* for 9 Months; to effect which, I make this fourth Number (found as before) to be my ſecond Number in the next Queſtion, I ſay, if 100*l.* require 4*l.* 10*s.* what will 75*l.* require? This Queſtion I find (by the ſaid 3d Rule of the 11th Chapter) to be direct, and by the ſaid 7th, 8th, and 10th Rules of the 10th Chapter, I find the Anſwer to be as before, *viz.* 3*l.* 7*s.* 6*d.*

The Operation of this Rule in the following Queſtions, are purpoſely omitted, to try the Learner's Capacity.

Queſt.

Queſt. 2. A ſecond Example in this Rule may be as followeth, *viz.* A Carrier receiving 42*s.* for the Carriage of 3 C. Weight 150 Miles, I demand how much he ought to receive for the Carriage of 7*C.* 3*qrs.* 14*lb* 50 Miles at that Rate? *Anſwer*, 36*s.* 9*d.*

Queſt. 3. A Regiment of 936 Soldiers eat up 351 Quarters of Wheat in 168 Days, I demand how many Quarters of Wheat 11232 Soldiers will eat in 56 Days at that Rate? *Anſwer*, 1404 Quarters.

Queſt. 4. If 40 Acres of Graſs be mowed by 8 Men in 7 Days, how many Acres ſhall be mowed by 24 Men in 28 Day? *Anſwer*, 480 Acres.

Queſt. 5. If 48 Buſhels of Corn (or other Seed) yield 576 Buſhels in a Year, how much will 240 Buſhels yield in 6 Years at that Rate? That is to ſay, if there were ſowed 240 Buſhels every one of the 6 Years? *Anſwer*, 17280 Buſhels.

Queſt. 6. If 40 Shillings be the Wages of 8 Men for 5 Days, what will be the Wages of 32 Men for 24 Days? *Anſwer*, 768 Shillings, or 38*l.* 8*s.*

Queſt. 7. If 14 Horſes eat 56 Buſhels of Provender in 16 Days, how many Buſhels will 20 Horſes eat in 24 Days? *Anſwer*, 120 Buſhels.

Queſt. 8. If 8 Cannons in one Day ſpend 48 Barrels of Powder, I demand how many Barrels 24 Cannons will ſpend in 12 Days at that Rate? *Anſwer*, 1728 Barrels.

Queſt 9. If in a Family conſiſting of 7 Perſons, there are drank out 2 Kilderkins of Beer in 12 Days, how many Kilderkins will there be drank out in 8 Days, by another Family conſiſting of 14 Perſons? *Anſwer*, 48 Gallons, or 2 Kilderkins and 12 Gallons.

Queſt. 10. An Uſurer put 75*l.* out, to receive Intereſt for the ſame, and when it had continued 9 Months, he received for Principal and Intereſt 78*l.* 7*s.* 6*d.* I demand at what Rate *per Cent. per Annum* he received Intereſt? *Anſwer*, 6*l.* *per Cent. per Annum.*

CHAP. XIII.

The Double Rule of Three Inverſe.

THE Double Rule of Three Inverſe is, when a Queſtion in the Double Rule of Three is reſolved by two ſingle Rules of Three, and one of thoſe ſingle Rules falls out to be Inverſe, or requires a fourth Number in Proportion reciprocal (for both Queſtions are never Inverſe.)

2. In

2. In all Queſtions of the Double Rule of Three (as ell Inverſe as Direct) you are, in the diſpoſing of the 5 iven Numbers, to obſerve the 7th Rule of the 12th Chap. nd in reſolving of it by two ſingle Rules, obſerve to make hoice of your Numbers for the firſt and ſecond ſingle ueſtions according to the Directions given in the 8th Rule f the ſame Chapter, and in the Example following, *viz.*

Queſt. 1. If 100*l.* Principal in 12 Month' gain 6*l.* Intereſt, what Principal will gain 3*l.* 7*s.* 6*d.* in 9 Months?

This Queſtion is an Inverſion of the firſt Queſtion of he 12th Chapter, and may ſerve for a Proof thereof.

In order to a Reſolution, I diſpoſe of the 5 given Numbers according to the 7th Rule of the laſt Chapter; and being ſo diſpoſed, they will ſtand as follow.

```
12      100     9
 6              3  7  6
```

Or thus,

```
 l.             l. s. d.
 6      100     3  7  6
12              9
```

Here obſerve, That according to the 8th Rule of he 12th Chapter, the firſt Queſtion (if you take it from he 5 Numbers, as they are ordered or placed firſt) will be, if 12 Months require 100*l.* Principal, what will 9 Months require to make the ſame Intereſt? This (according to the 3d Rule of the 11th Chapter) is Inverſe, and the Anſwer will be found (by the 2d Rule of the 11th Chapter) to be 133*l.* 6*s.* 8*d.* The ſecond Queſtion then will be, if 6*l.* Intereſt require 133*l.* 6*s.* 8*d.* Principal; how much Principal will 3*l.* 7*s.* 6*d.* require? This is a direct Rule, and the Anſwer in a direct Proportion is 75*l.* See the Work.

First I ſay,

```
 M.    l.    M.
 12   100    9
      12
   ---------
 9) 1200 (133  6  8
      ..
     9                 l.   s.  d.
   ----
     30    Facit      133   6   8
     27
   ----
     30
     27
   ----
     (3)
     20
   ----
 9)  60 (6 s.
     54
   ----
     (6)
     12
   ----
 9)  72 (8 d.
     72
   ----
     (0)
```

Then

Then I say,

l.		*l.*	*s.*	*d.*		*l.*	*d.*	*d.*
If 6	:	133	6	8	: :	3	7	6

240 — 20 — 20

1440 *d.* — 2666 — 67

12 — 12

5340 — 140

2666 — 67

32000 — 810 *d.*

810

320000

256

-2 10

1440) 82000,0(1800(75*l.*

....

144 — 168

1152 — 120

1152 — 120

(0) — (0)

So that by the foregoing Work I find that if 6*l.* Interest be gained by 100*l.* in 12 Months, 3*l.* 7*s.* 6*d.* will be gained by 75*l.* in 9 Months.

But if the Resolution had been found out by the Numbers as they are ranked in the second Place, then the second Question in the second Rule would have been Inverse, and the first Question Direct, and the Conclusion the same with the first Method, *viz.* 75*l.*

Quest. 2. If a Regiment consisting of 936 Soldiers can eat up 351 Quarters of Wheat in 168 Days, how many Soldiers will eat up 1400 Quarters in 56 Days, at that Rate? *Answer* 11200 Soldiers.

Quest. 3. If 12 Students in 8 Weeks spend 48*l.* I demand how many Students will spend 288*l.* in 18 Weeks? *Answer* 32 Students.

Quest. 4. If 48*l.* serve 12 Students 8 Weeks, how many Weeks will 288*l.* serve 4 Students? *Answ.* 144 Weeks.

Quest. 5. If when a Bushel of Wheat cost 3*s.* 4*d.* the Penny Loaf weighing 12 Ounces, I demand the Weight of the Loaf worth 9*d.* when the Bushel cost 10*s.* *Answ.* 36 *oz.*

Quest. 6. If 48 Pioneers in 12 Days cast a Trench 24 Yards long, how many Pioneers will cast a Trench 168 Yards long in 16 Days? *Answer* 252 Pioneers.

Quest 7. If 12C.wt being carried 100 Miles, cost 5*l.* 12*s.* I desire to know how many C.wt may be carried 150 Miles for 12*l.* 12*s.* at that Rate? *Ans.* 18C.

Quest.

Queſt. 8. If when Wine is worth 30*l. per* Ton, 20*l.* worth is ſufficient for the Ordinary of 100 Men, how many Men will 4*l.* worth ſuffice when it is worth 24*l. per* Ton? *Anſwer*, 25 Men.

Queſt. 9. If 6 Men in 24 Days mow 72 Acres, in how many Days will 8 Men mow 24 Acres? *Anſw.* in 6 Days.

Queſt. 10. If when the Ton of Wine is worth 30*l.* 100 Men will be ſatisfied with 20*l.* worth, I deſire to know what the Ton is worth when 4*l.* worth will ſatisfy 25 Men at the ſame Rate? *Anſwer*, 24*l. per* Ton.

CHAP. XIV.

The Rule of Three compoſed of five Numbers.

THE Rule of Three compoſed is, when Queſtions (wherein there are five Numbers given, to find a ſixth in proportion thereunto) are reſolved by one ſingle Rule of Three compoſed of five given Numbers.

2. When Queſtions may be performed by the Double Rule of Three Direct, and it is required to reſolve them by the Rule of Three compoſed; firſt order or rank your Numbers according to the 7th Rule of the 12th Chap. then

The Rule is,

Multiply the Terms or Numbers (that ſtand one over the other in the firſt Place) the one by the other, and make their Product the firſt Term in the Rule of Three Direct; then multiply the Terms that ſtand one over the other in the third Place, and Place their Product for the third Term in the Rule of Three Direct, and put the middle Term of the 3 uppermoſt for a ſecond Term; then having found a fourth Proportional direct to theſe three, this fourth Proportional ſo found ſhall be the Anſwer required.

So the firſt Queſtion of the 13th Chapter being propoſed, *viz.* if 100*l.* in 12 Months gain 6*l.* Intereſt, what will 75*l.* gain in 9 Months?

The Numbers being ranged or placed as is there directed and done, then I multiply the two firſt Terms 100 and 12 the one by the other, and their Product is 1200 for the firſt Term; then I multiply the laſt two Terms 75 and 9 together, and their Product is 675 for the third Term: Then I ſay, as 1200 is to 6, ſo is 675 to the Anſwer, which by the Rule of Three Direct will be found to be 3*l.* 7*s.* 6*d.* as was before found.

3. But if the Queſtion is to be anſwer'd by the Double Rule of Three Inverſe, then (having placed the 5 given Terms as before) multiply the lowermoſt Term of the firſt Place

Place by the uppermoſt Term of the third Place, and pu the Product for the firſt Term; then multiply the upper moſt Term of the firſt Place by the lowermoſt Term of the third Place, and put the Product for the third Term, and the ſecond Term of the three higheſt Numbers for the middle Term of thoſe two; then if the Inverſe Proportion is found in the uppermoſt three Numbers, the fourth Proportional direct to theſe three will be the Anſwer. So the firſt Queſtion in the 13th Chapter being ſtated, *viz.* if 100*l.* Principal in 12 Months gain 6*l.* Intereſt, what Principal will gain 3*l.* 7*s.* 6*d.* in 9 Months? State the Numbers as there directed in the firſt Order, *viz.*

M.	*l.*	*M.*
12	100	9
l.		*l.* *s.* *d.*
6		3 7 9

Then reduce the 6*l.* and 3*l.* 7*s.* 6*d.* into Pence, the 6*l.* is 1440*d.* and 3*l.* 7*s.* 6*d.* is 810*d.* then multiply 1440 by 9, the Product is 12960 for the firſt Term in the Rule of Three Direct, and multiply 810 by 12, the Product is 9720 for the third Term; then I ſay, as 12960 is to 100*l.* ſo is 9720 to the Anſwer, *viz.* 75*l.* as before. But if the Terms had been placed after the ſecond Order, *viz.*

l.		*l.*		*l.*	*s.*	*d.*
6	:	100	: :	3	7	6
M.				*M.*		
12				9		

Then the Inverſe Proportion is found in the loweſt Numbers, and having compoſed the Numbers for a ſingle Rule of Three, as in the ſecond Rule foregoing; then the Anſwer muſt be found by a ſingle Rule of Three Inverſe; for here it falls out to multiply 810 by 12 for the firſt Number, 1440 by 9 for the third Number; and then you muſt ſay, as 9720 is to 100*l.* ſo is 12960 to the Anſwer, which by Inverſe Proportion will be found to be 75*l.* as before.

The Queſtion in the 12th and 13th Chapters may ſerve for thy farther Experience.

CHAP. XV.

Single Fellowſhip.

FEllowſhip is that Rule of Plural Proportion whereby we ballance Accompts depending between diverſe Perſons, having put together a general Stock, ſo that they may every Man have his proportional Part of Gain, or ſuſtain his proportional Part of Loſs.

2. The

2. The Rule of Fellowſhip is either ſingle, or it is uble.

3. The ſingle Rule is, when the Stocks propounded are gle Numbers, without any reſpect or relation to Time, ch Partner continuing his Money in Stock for the ſame ime.

4. In the ſingle Rule of Fellowſhip the Proportion is, as e whole Stock of all the Partners is in proportion to the tal Gain or Loſs, ſo is each Man's particular Share in the ock, to his particular Share in the Gain or Loſs. Therere take the Total of all the Stocks for the firſt Term in the ule of Three, and the whole Gain or Loſs for the ſecond erm, and the particular Stock of any one of the Partners r the third Term, then multiply and divide according to e ſeventh Rule of the 9th Chapter, and the fourth proortional Number is the particular Loſs or Gain of him hoſe Stock you made your ſecond Number, wherefore peat the Rule of Three as often as there are particular tocks or Partners in the Queſtion, and the fourth Terms roduced upon the ſeveral Operations are the reſpective ain or Loſs of thoſe particular Stocks given, as in the xample following.

Queſt. 1. Two Perſons, *viz.* *A* and *B*, bought a Tun of ine, for 20*l.* of which *A* paid 12*l.* and *B* paid 8*l.* and ey gained in the Sale thereof 5*l.* now I demand each an's Share in the Gain, according to his Stock?

Firſt, I find the Sum of all their Stocks, by adding them gether, *viz.* 12*l.* and 8*l.* which are 20*l.* then acrding to this Rule, I ſay firſt, if 20*l.* (the Sum of their Stocks) require 5*l.* the total Gain, how much will 12*l.* (the Stock of *A*) require? Multiply and ivide by the 7th Rule of the 9th Chapter, and the nſwer is 3*l.* for the Share of *A* in the Gain; then again ay, if 20*l.* require 5*l.* what will 8*l.* require? The Anwer 2*l.* which is the Gain of *B*; ſo I conclude the Share of in the Gain is 3*l.* and the Share of *B* in the Gain is 2*l.* hich in all is 5*l.*

12
8
20*l.*

	l.		*l.*		*l.*
If	20	:	5	: :	12

12
20) 60 (3*l.*
60
(0)

	l.		*l.*		*l.*
If	20	:	5	: :	8

8
20) 40 (2*l.*

Queſt.

Queſt. 2. Three Merchants, *viz. A, B* and *C*, enter up a joint Adventure, *A* put into the common Stock 78*l.* put in 117*l.* and *C* put in 234*l.* and they find (when th make up their Accounts) that they have gained in 264*l.* now I deſire to know each Man's particular Share the Gain?

Firſt, I add their particular Stocks together, and th Sum is 429*l.* then ſay, if 429*l.* gain 264*l.* what will 78*l.* gain? And what will 117*l.* and what will 234*l.* (the Stock, of *A, B* and *C*) gain? Work by three ſeveral Rules of Three, and you will find that

1
2
Sum 4

$$\text{The Gain of } \left\{\begin{matrix} A \\ B \\ C \end{matrix}\right\} \text{ is } \left\{\begin{matrix} 48 \\ 72 \\ 114 \end{matrix}\right.$$

Sum 264

Queſt. 3. Four Partners, *viz. A, B C* and *D*, among them built a Ship, which coſt 1730*l.* of which *A* paid 34 *B* 519*l.* *C* 692*l.* and *D* 173*l.* and her Freight for a certa Voyage is 370*l.* which is due to the Owners or Builders demand each Man's Share therein, according to his Char in building her?

Anſwer, $\left\{\begin{matrix} A \\ B \\ C \\ D \end{matrix}\right.$ $\begin{matrix} 74 \\ 111 \\ 148 \\ 37 \end{matrix}$

370

Queſt. 4. *A, B* and *C* inter into Partnerſhip for a certa Time, *A* put into a common Stock 364*l.* *B* put in 48 *C* put in 500*l.* and they gained 867*l.* now I demand ea Man's Share in the Gain, proportionable to his Stock?

A	234	9	3	$\frac{314}{1346}$
B	310	9	5	$\frac{62}{1346}$
C	722	1	3	$\frac{430}{1346}$
Sum	867	0	0	

5. To prove the ſingle Rule of Fellowſhip add ea Man's particular Gain or Loſs together, and if the total Sum is equal to the general Gain or Loſs, then is the Work rightly performed, but otherwiſe it is er neous. *Example*; In the firſt Queſtion of this Chapter, t Anſwer was, That the Gain of *A* was 3*l.* and the Gain *B* 2*l.* which added together makes 5*l.* equal to the to Gain given.

The Proof of the R of Single Fellowſh

If in finding out the particular Shares of the ſever Partne

Partners, any Thing remaining after Diviſion is ended, ſuch Remainders muſt be added together, (they being all Fractions of the ſame Denomination) and their Sum divided by the common Diviſor in each Queſtion, *viz.* the total Stock, and the Quotient added to the particular Gains; and then if the total Sum is equal to the total Gain, the Work is right, otherwiſe not.

As in the 4th Queſtion, the Remainders were 354, 62 and 930, which added together make 1346, which divided by 1346 (the Sum of their Stocks) the Quotient is 1*d.* which I add to the Pence, *&c.* and the Sum of their Shares is 897*l.* equal to the total Gain, wherefore I conclude the Work is right.

CHAP. XVI.

Double Fellowſhip.

DOuble Fellowſhip is, when ſeveral Perſons enter into Partnerſhip for unequal Time; that is, when every Man's particular Stock hath relation to a particular Time.

2. In the Double Rule of Fellowſhip, multiply each particular Stock by its reſpective Time, and having added the ſeveral Products together, make their Sum the firſt Number (or Term) in the *Rule of Three*, and the total Gain or Loſs the ſecond Number, and the Product of any one's particular Stock by his Time the third Term, and the fourth Number in proportion thereunto is his particular Gain or Loſs, whoſe Product of Stock and Time is your third Number.

Then repeat (as in *Single Fellowſhip*) the *Rule of Three*, as often as there are Products (or Partners) and the four Terms thereby invented, are the Numbers required.

Example.

Queſt. 1. *A* and *B* enter Partnerſhip; *A* put in 40*l.* for 3 Months, *B* put in 75*l.* for 4 Months, and they gained 70*l.* now I demand each Man's Share in the Gain, proportional to his Stock and Time? *Anſwer*, *A* 20*l.* *B* 50*l.*

To reſolve this Queſtion, I firſt multiply the Stock of *A*, (*viz.* 40*l.*) by its Time (3 Months) and the Product is 120; then I multiply the Stock of *B* by its Time, *viz.* 75*l.* by 4, and it produceth 300, which I add to the Product of *A*, his Stock and Time, and the Sum is 420. Then by the Rule of Three Direct I ſay, as 420 (the Sum of the Products) is to 70, (the total Gain) ſo is 120 the Product of *A*, his Stock and Time) to 20*l.* (the Share of

	l.	*l.*
	40	75
	3	4
A	120	*B* 300
		120
		Sum 420

of *A* in the Gains) Then I ſay again, as 420 is to 70, ſo is 300 (the Product of *B* his Stock and Time) to 50*l.* (the Share of *B* in the Gains: And that each is to have for his Share.

Queſt. 2. *A*, *B* and *C* make a Stock for 12 Months, *A* put in at firſt 364*l.* and 4 Months after that he put in 40*l.* *B* put in at firſt 408*l.* and at the End of the 7 Months he took out 86*l.* *C* put in at firſt 148*l.* and 3 Months after he put in 86*l.* more, and 5 Months after that he put in 100*l.* more, and at the End of 12 Months their Gain is found to be 1436*l.* I deſire to know each Man's Share in the Gains, according to his Stock and Time?

Firſt, I conſider that the whole Time of their Partnerſhip is 12 Months: Then I proceed to find out the ſeveral Products, of Stock and Time, as followeth:

A had at firſt 364*l.* for 4 Months, wherefore that Product is	1456
Then he put in 40*l.* which with the firſt Sum makes 404*l.* which continued the Remainder of the Time, *viz.* 8 Months and that Product is	3232
The Sum of the Products of the Stock and Time of *A* is	4688
B had 408*l.* in 7 Months, whoſe Product is	2856
And then took out 86*l.* therefore he left in Stock 322*l.* which continued the reſt of the Time, *viz.* 5 Months, whoſe Product is	1610
The Sum of the Products of the Stock and Time of *B* is	4466
C put in 148*l.* for 3 Months, whoſe product being multiplied by 3, is	444
Then he put in 86*l.* which added to the firſt, (*viz.* 148*l.*) makes 234*l.* which lay in Stock 5 Months, and their Product is	1170
Then he put in 100*l.* more, ſo then he had in Stock 334*l.* which continued the Remainder of the Time, 4 Months, which multiplied together, produces	1336
The Sum of the Product of the Money and Time of *C* is	2950
B	4466
A	4688
The total Sum of all the Products is	12104

Then I ſay, as 12104 is to 1436 (the total Gain) ſo is 4688 to the Share of *A* in the total Gain, *&c.* go on as in the foregoing Examples, and you will find their Shares in the Gain to be as followeth, *viz.*

Anſwer

Answer,

The Share of $\left\{\begin{matrix}A\\B\\C\end{matrix}\right\}$ is $\left\{\begin{matrix}556 & 03 & 6\frac{6192}{12104}\\ 529 & 16 & 9\frac{5496}{12104}\\ 349 & 19 & 8\frac{4416}{12104}\end{matrix}\right.$

1436 00 0

Queſt. 3. Three Graſiers, *A*, *B* and *C*, take a Piece of Ground for 46*l.* 10*s.* in which *A* put 12 Oxen for 8 Months, *B* put in 16 Oxen for 5 Months, and *C* put 18 Oxen for 4 Months; now the Queſtion is, what each Man ſhall pay of the 46*l.* 10*s.* for his Share in that Charge?

$\left\{\begin{matrix}A\\B\\C\end{matrix}\right\}$ ſhall pay $\left\{\begin{matrix}18 & 00\\ 15 & 00\\ 13 & 10\end{matrix}\right.$

46 10

3. The Proof of this Rule is the ſame with that of Single Fellowſhip, laid down in the 5th Rule of the 15th Chapter; and note, that

If a Loſs be ſuſtained inſtead of a Gain among Partners, every Man's Share to be born in the Loſs, is to be found after the ſame Method as their Gain, whether their Stocks be for equal or unequal Time.

CHAP. XVII.

Alligation Medial.

1. THE Rule of Alligation is that Rule in plural Proportion, by which we reſolve Queſtions wherein is a Compoſition or Mixture of diverſe Simples, as alſo it is uſeful in Compoſition of Medicines, both for Quantity, Quality or Price: And its Species are two, *viz.* Medial and Alternate.

2. Alligation Medial is, when having the ſeveral Quantities and Prices of ſeveral Simples propounded, we diſcover the mean Price or Rate of any Quantity of the Mixture compounded of thoſe Simples, and the Proportion is,

As the Sum of the Simples to be mingled is to the total Value of all the Simples, ſo is any Part or Quantity of the Compoſition or Mixture to its mean Rate or Price.

Queſt. 1. A Farmer mingled 20 Buſhels of Wheat, at 5*s.* *per* Buſhel, and 36 Buſhels of Rye at 3*s.* *per* Buſhel, with 40 Buſhels of Barley at 2*s.* *per* Buſhel; now I deſire to known what one Buſhel of that Mixture is worth?

To reſolve this Queſtion, add together the given Quantities and their Value, which is 96 Buſhels, whoſe total Value is 14*l.* 8*s.* as appeareth by the Work following; for

Buſhels

Bushels			*l.*	*s.*
20 of Wheat,	at 5*s.* *per*	Bushel, is	5	0
36 of Rye,	at 3*s.* *per*	Bushel, is	5	8
40 of Barley,	at 2*s.* *per*	Bushel, is	4	0
The Sum of their given Quantities is 96, and their Value is			14	8

Then say, by the Rule of Three Direct, if 96 Bushels cost or is worth 14*l.* 8*s.* what is one Bushel worth?

Bush.	*l.*	*s.*	*Bush.*
96	14	8	1 Bushel

20

96) 288 (3 *s.*

288 *Facit* 3*s.* *per* Bushel.

(0)

Queſt. 2. A Vintner mingled 15 Gallons of Canary at 8*s.* *per* Gallon, with 20 Gallons of Malaga at 7*s.* 6*d.* *per* Gallon, with 10 Gallons of Malaga at 6*s.* 4*d.* *per* Gallon, and 24 Gallons of White-wine at 4*s.* *per* Gallon, now I demand what a Gallon of this Mixture is worth? Work as in the laſt Queſtion, and you will find the Anſwer to be 6*s.* 2*d.* 2*qrs.* $\frac{4}{69}$.

Queſt. 3. A Grocer hath mingled 3 C. of Sugar at 56*s.* *per* C. with 4 C. of Sugar at 3*l.* 14*s* 8*d.* *per* C. and with 6C. at 1*l.* 17*s.* 4*d.* *per* C. I deſire to know the Price of a C.wt. of that Mixture? *Anſwer*, 2*l.* 13*s.* 1*d* $\frac{7}{13}$.

3. The Proof of this Operation is by the Price of any Quantity of the Mixture, to find out the total Value of the whole Compoſition, and if it is equal to the total Value of the ſeveral Simples, the Work is right, otherwiſe not. (*The Proof of* Alligation Medial.) As in the firſt Example, the Anſwer to the Queſtion was that 3*s.* is the Price of 1 Buſhel; wherefore I ſay, by the Rule of Proportion, if 1 Buſhel be 3*s.* what is 96 Buſhels? *Anſwer*, 14*l.* 8*s.* which is the total Value of the ſeveral Simples; wherefore the Work is right.

CHAP. XVIII.

Alligation Alternate.

1. ALligation Alternate is, when there are given the particular Prices of ſeveral Simples, and thereby we diſcover ſuch Quantities of thoſe Simples, as being mingled together, ſhall bear a certain Rate propounded.

2. When

2. When ſuch a Queſtion is ſtated, place the given Prices the Simples one over the other, and the propounded ice of the Compoſition againſt them in ſuch Sort that it ay repreſent a Root, and they as ſo many Branches inging from it, as in the following Example.

Queſt 1. A certain Farmer is deſirous to mix 20 Buſhels Wheat at 5*s.* or 60*d. per* Buſhel, with Rye at 3*s.* or 36*d.* Buſhel, and with Barley at 2*s* or 24*d. per* Buſhel, and ats at 1*s.* 6*d. per* Buſhel, and deſireth to mix ſuch a Quany of Rye, Barley and Oats, with the 20 Buſhels of heat, as that the whole Compoſition may be worth 2*s.* . or 32*d. per* Buſhel.

The Prices of the Simples being placed according to e laſt Rule (with the Price of the Compoſition proounded as a Root to them) will ſtand as followeth.

32 { 60 Pence
36
24
18

3. Having thus placed the given Numbers, you are to nk the ſeveral Rates of the Simples one to the other, by rtain Arches, in ſuch ſort that one that is leſſer than the ean Rate, may be coupled to another that is greater than e mean Rate; ſo the Queſtion laſt propounded will ſtand,

1. *Thus,* 2. *Or thus,* 3. *Or thus,*

4. Then take the Difference between the Root and the veral Branches, and place the Difference of each againſt e Number or Branch with which it is coupled or linked, d having taken all the Differences and placed them as oreſaid, then thoſe Differences ſo placed will ſhew you e Number of each Simple to be taken to make a Comoſition to bear the mean Rate propounded.

So the Branches of the laſt Queſtion being linked toether, as in the firſt manner, I ſay, the Difference between 2 and 60 is 28, which I put againſt 18, becauſe 60 is nked with 18; then the Difference between 32 and 36 is which I put againſt 24, becauſe 36 is nked or coupled with 24; then I ſay e Difference between 32 and 24 is 8, hich I placed gainſt 36 (for the Rean aforeſaid) then I ſay, the Difference tween 32 and 18 is 14, which I place againſt 60, and then e Work will ſtand as you ſee in the Margent.

So

So I conclude that a Compoſition made of 14 Buſhels Wheat at 60*l. per* Buſhel, and 8 Buſhels of Rye at 36 *per* Buſhel, and 4 Buſhels of Barley at 24*d. per* Buſhel, and 28 Buſhels of Oats at 18*d. per* Buſhel, will bear the mean Price of 32*d.* or 2*s.* 8*d. per* Buſhel. And here obſerve, that in the Compoſition there is but 14 Buſhels of Wheat, but I would mingle 20 Buſhels; and this Kind (or rather Caſe of Alligation Alternate, *viz.* when there is given a certain Quantity of one of the Simples, and the Quantities of the reſt ſought to mingle with the given Quantity, that the Whole may bear a Price propounded) is called Alternation partial.

And the Proportion to find out the ſeveral Quantities to be mingled with the given Quantity, is thus,

As the Difference annexed to the Branch, that is, the Value of an Integer of the given Quantity, is to the other particular Differences, ſo is the Quantity given to the ſeveral Quantities required.

So here, to find how much Rye, Barley and Oats muſt be mingled with the 20 Buſhels of Wheat, I ſay, by the Rule of Three Direct, if 14 Buſhels of Wheat require 8 Buſhels of Rye, what will 20 Buſhels of Wheat require? *Anſwer*, $11\frac{6}{14}$ Buſhels of Rye.

Again, if 14 Buſhels of Wheat require 4 Buſhels of Barley, what will 20 Buſhels of Wheat require? *Anſ.* $5\frac{1}{14}$ Buſhels of Barley. Again, I ſay, if 14 Buſhels of Wheat require 28 Buſhels of Oats what will 20 Buſhels of Wheat require? *Anſw.* 40 Buſhels of Oats.

And now I ſay, that 20 Buſhels of Wheat mingled with $11\frac{6}{14}$ Buſhels of Rye, and $5\frac{1}{14}$ Buſhels of Barley, and 40 Buſhels of Oats, each bearing the Rate as aforeſaid, will make a Compoſition, or Heap of Corn, that may yield 32*d. per* Buſhel.

But if the Branches had been coupled according to the ſecond Order or Manner, the Differences would have been thus placed, *viz* the Difference between 32 and 60 is 28, which I

$$32\left\{\begin{matrix}60\\36\\24\\18\end{matrix}\right.\left\{\begin{matrix}8\\14\\28\\4\end{matrix}\right.$$

ſet againſt 24, becauſe 60 is linked thereto; and the Difference between 32 and 36 is 4, which I ſet againſt 18; and the Difference between 32 and 24 is 8, which I ſet againſt 60; then the Difference between 36 and 18 is 14, which I ſet againſt his Yoke-fellow 36; and then I conclude, that if you mix'd 8 Buſhels of Wheat with 14 Buſhels of Rye, 28 Buſhels of Barley, and 40 Buſhels of Oats, each bearing the aforeſaid Prices, the

whole Mixture may be ſold for 32*d. per* Buſhel, as by the Work in the Margent.

You ſee by this Work we have found how many Buſhels of Rye, Barley and Oats ought to be mixed with 8 Buſhels of Wheat, and to find out how many of each ought to be mixed with 20 Buſhels of Wheat, I ſay, as 8 is to 14, ſo is 20 to 35 Buſhels of Rye. As 8 is to 28, ſo is 20 to 70 Buſhels of Barley, as 8 is to 4, ſo is 20 to 10 Buſhels of Oats; whereby I conclude, that if 20 Buſhels of Wheat I put 35 Buſhels of Rye, 70 Buſhels of Barley, and 10 Buſhels of Oats, each bearing the aforeſaid Price *per* Buſhel, that then a Buſhel of this Mixture will be worth 32*d.* or 2*s.* 8*d.*

And if the Branches had been linked as you ſee in the 3d Place, where each Branch bigger than the Root is link'd to two that are leſſer than the Root, then in this Caſe you muſt have placed the ſeveral Differences between the Root and Branches againſt thoſe two with which each is coupled; as firſt, the Difference between 32 and 60 is 28, which I ſet againſt 24 and 18, becauſe it is coupled with them both;

32	60	8	14	22
	36	8	14	22
	24	28	4	32
	18	28	4	32

then the Difference between 32 and 36 is 4, which I ſet likewiſe againſt 24 and 18, becauſe 36 is linked to them both; then the Difference between 32 and 24 is 8, which I put againſt 60 and 36, becauſe 24 is linked to them both, then the Difference between 32 and 18 is 14, which I put againſt 60 and 36, the Yoke-fellows of 18.

Laſtly, I draw a Line behind the Differences, and add the Differences which ſtand againſt each Branch, and put the Sum behind the ſaid Line againſt its proper Branch, as you ſee in the Margent.

And now by this Work I find that 22 Buſhels of Wheat mingled with 22 Buſhels of Rye, and 32 Buſhels of Barley, and 32 Buſhels of Oats, each bearing the ſaid Price, will make a Mixture bearing the mean Rate of 32*d. per* Buſhel.

And now to find how much of each of the reſt muſt be mingled with 20 Buſhels of Wheat, I ſay,

As 22 is to 22, ſo is 20 to 20 Buſhels of Rye. As 22 is to 32, ſo is 20 to 29 $\frac{2}{11}$ Buſhels of Barley. As 22 is to 32, ſo is 20 to 29 $\frac{2}{11}$ Buſhels of Oats.

Wherefore you ſee the Queſtions of Alligation Alternate will admit of more true Anſwers than one; for we have found three ſeveral Anſwers to this firſt Queſtion.

The Proof of Alligation partial.

Queſtions of Alligation partial are proved the ſame way with Queſtions in Alligation medial, which you may ſee in the 3d Rule of the 17th Chapter.

Queſt. 3. A Grocer hath 4 Sorts of Sugar, *viz.* of 12*d. per* lb, of 10*d. per* lb, of 6*d. per* lb, and of 4*d. per* lb, and would have a Compoſition worth 8*d. per lb*, the whole Quantity whereof ſhould contain 144 *lb* made of theſe four Sorts? I demand how much of each he muſt take?

Queſtions of this Nature are reſolved by that Part of Alligation Alternate, called by Arithmeticians *Alligation Total, viz.* where there is given the Sum and Prices of ſeveral Simples, to find out how much of each Simple ought to be taken to make the ſaid Sum or Quantity, ſo that it may bear a certain Rate propounded.

To reſolve this Queſtion, I place the ſeveral Prices of the Simples and mean Rate propounded, and link them together, as is directed in the 2d and 3d Rules of this Chapter, and place the Differences between the Root and Branches, according to the 4th Rule of this Chapter, which will then ſtand one of theſe three Ways, *viz.*

First

12	4	
10	2	
8		
6	2	
4	4	
	12	

Second

12	2	
10	4	
8		
6	4	
4	2	
	12	

Third

12	2, 4	6
10	2, 4	6
8		
6	4, 2	6
4	4, 2	6
		24

5. Then add the ſeveral Differences together, which I have done, and the Sums of the firſt and ſecond Order are 12 *lb*. and of the third 24 *lb* as you ſee above. But it is required that there ſhould be 144 *lb*. of the Compoſition; therefore to find the Quantity of each Simple to make the whole Compoſition 144 *lb*, obſerve this general Rule, *viz.*

As the Sum of the Differences is to the ſeveral Differences, ſo is the total Quantity of the Compoſition to the Quantity of each Simple.

So to find how much of each Sort of Sugar I ought to take to make 144lb at 8*d. per* lb.

As 12 is to 4, ſo is 144 to 48lb at 12*d. per* lb.
As 12 is to 2, ſo is 144 to 24lb at 10*d. per* lb.
As 12 is to 2, ſo is 144 to 24lb at 6*d. per* lb.
As 12 is to 4, ſo is 144 to 48lb at 4*d. per* lb.

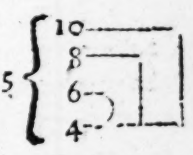
Whereby I find that 48lb. at 12*d. per* lb, and 24lb at 10*d. per* lb, and 24lb at 6*d. per* lb, and 48lb at 4*d. per* lb, will make a Compoſition of Sugar containing 144 lb, worth 8*d. per* lb.

But as the Branches are linked in the ſecond Order, the Anſwer will be 24lb at 12*d. per* lb, and 48lb at 10*d. per* lb, and 48lb at 6*d. per* lb, and 24lb at 4*d. per* lb, to make the ſaid Quantity, and to bear the ſaid Price.

And if you had worked as the Branches are linked from the third Order, then you would have found the Quantity of 36lb of each.

Queſt. 3. A Vintner hath 4 Sorts of Wine, *viz.* Canary at 10*s. per* Gallon, Malaga at 8*s. per* Gallon, Rheniſh Wine at 6*s. per* Gallon, and White Wine at 4*s. per* Gallon, and he is minded to make a Compoſition of them all of 60 Gallons, that they may be worth 5*s. per* Gallon, I deſire to know how much of each he muſt have?

The Number of Terms being ranked according to the ſecond Rule of this Chapter, the Branches will be linked as followeth, but will admit of no other manner of coupling, becauſe there is but one Branch that is leſſer than the Root, therefore all the reſt muſt be linked unto it; and the Difference between the Root and the three firſt Branches, *viz.* 10, 8 and 6, which are 5, and 3 and 1 muſt be ſet againſt 5 4 becauſe they are coupled with it; and the Difference between the Root, *viz.* 5 and 4, which is 1, muſt be ſet againſt the three other, becauſe it is linked to them all; ſo I find 1 Gallon of Canary, 1



Gallon of Malaga, 1 Gallon of Rheniſh Wine, and 9 Gallons of White Wine, priced as above, being mingled together, will be worth 5*s. per* Gallon, the Sum being 12 Gallons; but there muſt be 60 Gallons, wherefore I ſay,

As 12 is to 1, ſo is 60 to 5 Gallons of Canary.
As 12 is to 1, ſo is 60 to 5 Gallons of Malaga.
As 12 is to 1, ſo is 60 to 5 Gallons of Rheniſh.
As 12 is to 9, ſo is 60 to 45 Gallons of White Wine

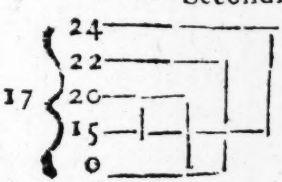
ſo that 5 Gallons of Canary, 5 Gallons of Malaga 5 Gallons of Rheniſh, and 45 of White Wine mingled together, will be in all 60 Gallons worth 5*s. per* Gallon, which was required.

Queſt. 4. A Goldſmith hath Gold of four ſeveral Sorts of Fineneſs, *viz.* of 24 Carects fine, and of 22 Carects fine, and of 20 Carects fine, and of 15 Carects fine, (*Read Ch p. 2. Def. of this Book*) and he would mingle ſo much of each with Alloy, that the whole Maſs of 28*oz* of Gold ſo mingled may bear 17 Carects fine; I demand how much of each he muſt take? The 2d and 3d Rules of this Chapter being obſerved, (for inſtead of the Alloy I put 0, becauſe it bears no Fineneſs, but it makes a Branch in the Operation) the Terms may be alligated, and the Differences added by any of theſe four Ways following, *viz.*

Firſt thus,

Sum 56

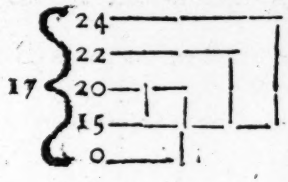
Secondly thus,



Sum 56

Thirdly

Thirdly thus,



3	2
2	2
2, 17	19
7, 5, 3.	15
3,	3

Sum 14.

Fourthly thus,

7, 5, 3	15
7, 5, 3	15
2, 17	19
2, 17	19
2, 17	19

Sum 87

More Ways may be given for the alligating or linking of the Terms is this Question, but these, if well practised, are sufficient for understanding the Rules of Alligation.

The Proof of Alternation Total.

In Questions of Alligation Total the Answer is given true, when the Sum of each of the Quantities of Simples found, agrees with the Sum or Quantity propounded; as in the last Question, the Answer was 8*oz.* 10 *pwt.* of 24 Carects fine, 1*oz.* of 22 Carects fine, 9*oz.* 10*pwt.* of 20 Carects fine, 4*oz.* of 15 Carects fine, and 5*oz.* of Alloy, which added together make 28*oz.* the Quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

1. WHAT a Vulgar Fraction is, hath been already shewed in the 1st Chapter of this Book, to which refer the Reader to look cautiously into.

2. To reduce a Vulgar Fraction, observe carefully these eight following Rules,

1. To reduce a mix'd Number into an improper Fraction.

2. To reduce a whole Number into an improper Fraction.

3. To reduce an improper Fraction into its equivalent whole (or mix'd) Number.

4. To

4. To reduce a Fraction into the loweſt Terms equivalent to the Fraction given.

5. To find the Value of a Fraction in the known Parts of Coin, Weight, Meaſure, *&c.*

6. To reduce a compound Fraction to a ſimple one of the ſame Value.

7. To reduce diverſe Fractions having unequal Denominations, to Fractions of the ſame Value having an unequal Denominator.

8. To reduce a Fraction of one Denomination to another of the ſame Value.

I. *To reduce a mix'd Number to an improper Fraction.*

The Rule is,

Multiply the Integer Part (or whole Number) by the Denominator of the Fraction, (*Vide Chap.* 1. *Defin.* 31.) and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator, ſo this new Fraction ſhall be equal to the mix'd Number given. As for Example:

1. Reduce $18\frac{3}{7}$ into an improper Fraction; multiply the whole Number 18 by 7 the Denominator, and to the Product add the Numerator 3, the Sum is 129, which put over the Denominator 7, and it makes $\frac{129}{7}$ for the Anſwer, as followeth.

$$18\frac{3}{7}$$

$$\text{Facit } \frac{129}{7}$$

2. Reduce $183\frac{5}{11}$ to an improper Fraction, *facit*, $\frac{2048}{11}$.

3. Reduce $50\frac{13}{22}$ to an improper Fraction, *facit*, $\frac{1113}{22}$.

II. *To reduce a whole Number into an improper Fraction.*

The Rule is, Multiply the given Number by the intended Denominator and place the Product for the Numerator over it. (*Vide Chap.* 1. *Defin.* 23.) As for Example:

1. Let it be required to reduce 15 into a Fraction whoſe Denominator ſhall be 12. To effect which, I multiply 15 by the intended Denominator (12) the Product is 180 which I place over 12 as a Numerator, and it makes $\frac{180}{12}$, which is equal to 15 as was required; as *per* Margent.

$$\begin{array}{r} 15 \\ \times\ 12 \\ \hline 30 \\ 15 \\ \hline 180 \end{array}$$

$$\text{Facit } \frac{180}{12}$$

2. Reduce

2. Reduce 36 into an improper Fraction, whose Denominator shall be 26, *facit* $^{936}/_{26}$.

3. Reduce 135 into an improper Fraction, whose Denominator shall be 16, *facit* $^{2160}/_{16}$.

III. *To reduce an improper Fraction into its equivalent whole or mix'd Number.*

The Rule is, Divide the Numerator by the Denominator, and the Quotient is the whole Number equal to the Fraction; and if any Thing remain, put it for a Numerator over the Divisor. *Example.*

1. Reduce $^{436}/_{8}$ into its equivalent mix'd Number. Divide the Numerator 436 by the Denominator 8, and the Quotient is 54, and 4 remains, which put for a Numerator over the Divisor 8, the Answer is $54\frac{4}{8}$, as followeth.

8) 436 (54

40

36

32

(4)

Facit $54\frac{4}{8}$

2. Reduce $^{3476}/_{15}$ to a mix'd Number. *Facit* $231\frac{11}{15}$.

3. Reduce $^{15576}/_{136}$ to a mix'd Number. *Facit* $114\frac{72}{136}$.

IV. *To reduce a Fraction into its lowest Terms, equivalent to the Fraction given.*

The Rule is, 1. If the Numerator and Denominator are even Numbers, take half the one and half of the other, as often as may be, and when either of them falls out to be an odd Number, then divide them by any Number that you can discover will divide both Numerator and Denominator without any Remainder; and when you have thus proceeded as low as you can reduce them, then this new Fraction so found out shall be the Fraction you desire, and will be equal in Value to the given Fraction.

Example 1. Let it be required to reduce $^{192}/_{336}$ into its lowest Terms. First I take the half of the Numerator 192, and it is 96, then half of the Denominator, and it is 168, so that it is brought to $^{96}/_{168}$, and next to $^{48}/_{84}$, and by halfing still to $^{24}/_{42}$, and their half is $^{12}/_{21}$, and now I can no longer half it, because 21 is an odd &c. and I find 3 divides them both without any Remainder, and brings them to $^{4}/_{7}$, as *per* Margent.

192	96	48	24	12	4
336	168	84	42	21	7

So I conclude $\frac{4}{7}$ thus found to be equal in Value to the given Fraction $\frac{192}{336}$.

2. What is $\frac{1736}{19824}$ in its lowest Terms? *Answer*, $\frac{7}{81}$.

3. What is $\frac{13428}{15866}$ in its lowest Terms? *Answer*, $\frac{11}{13}$.

The best way to reduce a Fraction into its lowest Terms is, by finding a common Measure, *viz.* the greatest Number that will divide the Numerator and Denominator without any Remainder, and by that means reduce a Fraction to its lowest Terms at the first Work; and to find out the common Measure, divide the Denominator by the Numerator, and if any Thing remain divide your Divisor thereby, and if any Thing yet remain, then divide your last Divisor by it; do so until you find nothing remaining; then this last Divisor shall be your greatest common Measure, which will divide both Numerator and Denominator, and reduce them both into their lowest Terms at one Work.

Example 4. Reduce $\frac{228}{304}$ into its lowest Terms by a common Measure; to effect which I divide the Denominator 304 by the Numerator 228, and there remains 76; then I divide 228 (the first Divisor) by 76 (the Remainder) and it quotes 3, and nothing remains; wherefore the last Divisor 76 is the common Measure, by which I divide the Numerator of the given Fraction; *viz.* 228, it quotes 3 for a new Numerator; then I divide the Denominator 304 by 76, and it quotes 4 for a new Denominator, so that now I have found $\frac{3}{4}$ equal to $\frac{228}{304}$.

5. Reduce $\frac{6048}{7392}$ into its lowest Terms by a common Measure. *facit* $\frac{9}{11}$.

6. Reduce $\frac{30812}{70352}$ into its lowest Terms by a common Measure, *facit* $\frac{13}{86}$.

A Compendium.

Note, That if the Numerator and Denominator of a Fraction end each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the remaining Figures will be a Fraction of the same Value; *viz.* $\frac{3400}{7100}$ will be found to be reduced to $\frac{34}{71}$, by cutting off the two Cyphers from the Numerator and Denominator with a Dash of the Pen, thus, $\frac{34\,00}{71\,00}$, and $\frac{4600}{7000}$ will be $\frac{46}{70}$ thus, $\frac{46\,00}{70\,00}$, *&c.*

V. *To find the Value of a Fraction in the known Parts of Coin, Weights, &c.*

The Rule is, Multiply the Numerator by the Parts of the next inferior Denomination that are equal to an Unit of

the ſame Denomination with the Fraction; then divide the Product by that Denominator, and the Quote gives you its Value in the ſame Parts you multiplied by, and if any Thing remain, multiply it by the Parts of the next inferior Denomination, and divide as before; do ſo till you can bring it no lower, and the ſeveral Quotients will give you the Value of the Fraction as was required; and if any at laſt remain, place it for a Numerator over the former Denominator. Some few Examples will make the Rule plain.

1. What is the Value of $\frac{27}{29}$ *l. ſterling?* To anſwer this Queſtion, I multiply the Numerator 27 by 20, (the Shillings in a Pound) the Product is 540, which I divide by 29 (the Denominator) and the Quotient is 18*s.* and there remains 18, which I multiply by 12 Pence, and the Product (216) I divide by the Denominator 29, the Quotient is 7*d.* and 13 remains, which I multiply by 4 Farthings, the Product is 52, which I ſtill divide by 29, the Quotient is 1 *qr.* and there remaineth 23, which I put for a Numerator over the Denominator 29, ſo I find the Value of $\frac{27}{29}$*l.* to be 18*s.* 7*d.* 1 *qr.* $\frac{23}{29}$, as by the Work in the Margent, and after the ſame manner the Value of $\frac{11}{15}$ of a Pound *ſterling* is found out to be 14*s.* 8*d.*

$\frac{27}{29}$ *l.*
27
Multiply 20
29) 540 (18*s.* 7*d.* $1\frac{23}{29}$ *q.*
29
250
232
Rem. (18)
Mult. 12
36
18
29) 216 (7*d.*
203
Rem. (13)
Mul. 4
qr.
29) 52 ($1\frac{23}{29}$
29
Rem. (23)

	s.	*d.*	*qr.*
Facit	18	7	$1\frac{23}{29}$.

And ſo likewiſe you may find the Value of any Fraction either in Weight or Time, *&c.*

II *To reduce a compound Fraction to a Simple of the ſame Value.*

What a compound Fraction is, hath been ſhewn in *Chap. I. Definition* 24, and to reduce it to a ſimple Fraction of the ſame Value.

The Rule is; Multiply the Numerators continually, and place the laſt Product for a new Numerator, then multiply

the Denominators continually, and place the laſt Product for a new Denominator; ſo this ſingle Fraction ſhall be equal to the compound Fraction.

Example.

1. Reduce $\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{5}{8}$ to a ſimple Fraction.

Multiplying the Numerators, 2, 3 and 5 together, they make 30 for a new Numerator; then I multiply the Denominators 3, 5 and 8 together, and their Product is 120 for a Denominator, ſo the ſimple Fraction is $\frac{30}{120}$, and cutting off the Cyphers it is $\frac{3}{12}$, equal to the $\frac{1}{4}$ by the 4th Rule following.

5	3
3	2
15	6
8	5
120	30

Facit $\frac{30}{120}$, or $\frac{3}{12}$, or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{9}$ of $\frac{4}{7}$ of $\frac{11}{12}$? *Anſw.* $\frac{1540}{7560}$, or $\frac{154}{756}$, or $3\frac{77}{378}$ in its loweſt Terms.

3. What is $\frac{11}{12}$ of $\frac{13}{14}$ of $\frac{21}{29}$? *Anſwer,* $\frac{3003}{4872}$.

By this you may know how to find the Value of a compound Fraction, *viz.* firſt reduce it to a ſimple one, and then find out its Value by the 5th Rule foregoing.

Example 4. What is the Value of $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{8}{10}$ of a Pound *ſterl.*? *Anſ.* 11*s.* 3*d.*

VII. *To reduce Fractions of unequal Denominations to Fractions of the ſame Value, having equal Denominators.*

The Rule is, Multiply all the Denominators together, and the Product ſhall be the common Denominator; then multiply each Numerator into all the Denominators, except its own, and the laſt Product put for a Numerator over the Denominator found out as before; ſo this new Fraction is equal to that Fraction whoſe Numerator you multiply into the ſaid Denominator. Do ſo by all the Numerators given, and you have your Deſire.

Example.

1. Reduce $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$ and $\frac{7}{8}$ to a common Denominator. Multiply the Denominators 4, 5, 6 and 8 together continually, and the Product is 960 for the common Denominator; then multiply the Numerator 3 into the Denominators, 5, 6 and 8, and the Product is 720, which is the Numerator to 960 (found as before) ſo $\frac{720}{960}$ is equal to

first Fraction $\frac{3}{4}$; then I proceed to find a new Numerator to the ſecond Fraction, *viz.* $\frac{4}{5}$, and I multiply 4 (into all the Denominators except its own, *viz.*) into 4, 6 and 8, which produceth $\frac{768}{960}$, equal to $\frac{4}{5}$, then multiply the Numerator 5 into the Denominators, 4, 5 and 8, the Product is $\frac{800}{960}$, equal to $\frac{5}{6}$, then multiply the Numerator 7 into the Denominators 4, 5 and 6, the Product is $\frac{840}{960}$, equal to $\frac{7}{8}$ and the Work is done: So that for $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$ and $\frac{7}{8}$ I have $\frac{720}{960}$, $\frac{768}{960}$, $\frac{800}{960}$ and $\frac{840}{960}$.

2. Reduce $\frac{11}{12}$, $\frac{14}{23}$ and $\frac{19}{21}$ to a common Denominator, *faciunt* $\frac{5313}{5796}$, $\frac{5428}{5796}$ and $\frac{5244}{5796}$.

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either aſcending or deſcending. Aſcending, when a Fraction of a ſmaller is brought to a greater Denomination. Deſcending when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a leſſer to a greater Denomination, then make of it a compound Fraction, by comparing it with the intermediate Denominations between it, and that you would have it reduced to; then (by the 6th Rule foregoing) reduce your Compound to a ſimple Fraction, and the Work is done.

Example.

Queſt. 1. It is requir'd to know what Part of a Pound *Sterling* $\frac{5}{7}$ of a Penny is?

To reſolve this, I conſider that 1*d.* is $\frac{1}{12}$ of a Shilling, and a Shilling is $\frac{1}{20}$ of a Pound; wherefore $\frac{5}{7}d.$ is $\frac{5}{7}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound, which, by the ſaid 9th Rule, I find to be $\frac{5}{1680}$ of a Pound *Sterl.* of *Engliſh* Money.

Queſt. 2. What Part of a Pound *Troy-weight* is $\frac{4}{7}$ of a Penny-weight? *Anſw.* $\frac{4}{5}$ of $\frac{1}{20}$ of $\frac{1}{12}$, equal to $\frac{4}{1200}$ *Troy.*

3. When a Fraction is to be brought from a greater to a leſſer Denomination, then multiply the Numerator by the Parts contained in the ſeveral Denominations betwixt it and the Parts you would reduce it to; then place the laſt Product over the Denominator of the given Fraction.

Example.

Queſt. 3. I would reduce $\frac{3}{5}$ *l.* to the Fraction of 1*d.* to do which, I multiply the Numerator 3 by 20 and 12, the Product is 720, which I put over the Denominator 5, it makes $\frac{720}{5}$ of 1*d.* equal to $\frac{3}{5}$*l.*

Queſt. 4. What Part of an Ounce *Troy* is $\frac{5}{16}$ *lb*? *Anſwer* $\frac{5}{6}$ *oz.*

CHAP

CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their Sum for a Numerator to the common Denominator, which new Fraction is the Sum of all the given Fractions; and if it be improper, reduce it to a whole or mix'd Number, by the 3d Rule in the 19th Chapter.

Queſt. 1. What is the Sum of $\frac{7}{24}$, $\frac{9}{24}$, $\frac{16}{24}$ and $\frac{14}{24}$?

The Denominators are equal, *viz.* every one is 24, wherefore add the Numerators together, *viz.* 7, 9, 16 and 14, their Sum is 46, which put over the Denominator 24, it makes $\frac{46}{24}$, the Sum of the given Fractions, which will be reduced to the mixed Numbers $1\frac{22}{24}$ or $1\frac{11}{12}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7th Rule of Chap. 19, and then add the Numerators together, and put the Sum over the common Denominator, &c. as before in the laſt Example.

Queſt. 2. What is the Sum of $\frac{3}{5}$, $\frac{7}{8}$, $\frac{9}{10}$ and $\frac{11}{12}$?

The Fractions reduced to a common Denominator are $\frac{2880}{4800}$, $\frac{4200}{4800}$, $\frac{4320}{4800}$ and $\frac{4400}{4800}$, the Sum of their Numerators is 15800, which put over the common Denominator makes $\frac{15800}{4800}$, or $\frac{158}{48}$, equal to the mix'd Number $3\frac{14}{48}$ for the Sum required.

Queſt. 3. What is the Sum of $\frac{18}{21}$, $\frac{25}{49}$ and $\frac{36}{49}$?

Anſwer, $1\frac{375}{3915}$.

3. If you are to add mix'd Numbers together, then add the fractional Parts as before, and if their Sum be an improper Fraction, reduce it to a mix'd Number, and add its integral Part to the integral Parts of the given mix'd Numbers, and the Work is done.

Queſt. 4. What is the Sum of $13\frac{3}{4}$ and $24\frac{5}{8}$?

Firſt add the Fractions $\frac{3}{4}$ and $\frac{5}{8}$: the Sum is $1\frac{2}{32}$, then add the Integer 1 to 13 and 24, their Sum is 38, and put after it the Fraction $\frac{2}{32}$, it is $38\frac{2}{32}$ for the Anſwer, or it is $38\frac{1}{16}$.

Queſt. 5. What is the Sum of $48\frac{3}{7}$, $64\frac{5}{8}$ and $130\frac{1}{2}$?

Facit $243\frac{180}{224}$, or $2\frac{45}{56}$.

4. If any of the Fractions to be added is a compound Fraction, it muſt firſt be reduced to a ſimple Fraction by the 6th Rule of Chapter 19, and then add it to the reſt, according to the 2d Rule of this Chapter.

Exam-

Example.

Queſt. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$ and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$?
Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a ſimple Fraction, and it is $\frac{105}{192}$, which reduced with the other two, and added, are $24\frac{600}{608}$.

Queſt. 7. What is the Sum of $\frac{11}{12}$ and $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$?
Anſwer. $1\frac{5}{12}$.

5. If the Fractions to be added are not of one Denomination, they muſt be ſo reduced, and then proceed as before.

Queſt. 8. What is the Sum of $\frac{3}{4}$ *l.* and $\frac{5}{6}$ *s.*?
Of the given Fractions here, one is of a Pound, and the other the Fraction of a Shilling; and before you can add them together you muſt reduce $\frac{5}{6}$ *s.* to the Fraction of a Pound as the other is (by the 8th Rule of Chap. 19.) and it makes $\frac{5}{120}$ *l.* then $\frac{3}{4}$ and $\frac{5}{120}$ *l.* will be found to be $\frac{380}{480}$ *l.* or $\frac{38}{48}$ *l.* by the 7th Rule of Chap. 19. and in its loweſt Terms $\frac{19}{24}$ *l.* by the 4th Rule of Chap. 19.

It would have been the ſame (if by the latter Part of the 8th Rule of Chapter 19) you had reduced $\frac{3}{4}$ *l.* to the Fraction of a Shilling, which you would have found to have been $\frac{60}{4}$ *s.* which added to $\frac{5}{6}$ *s.* by the ſaid 17th Rule of the laſt Chapter, the Sum is $15s.\ \frac{20}{24}$, which is equal to the Sum found, as before, *viz.* $\frac{19}{24}$ *l.* for (by the 5th Rule of Chapter 19.) the Value of $\frac{1}{24}$ *l.* will be found to be 15 *s.* 10 *d.* and ſo will 15 *s.* $\frac{20}{24}$ be found to be juſt as much.

Queſt. 9. What is the Sum of $\frac{2}{3}$ *l.* $\frac{3}{5}$ *s.* and $\frac{3}{5}$ *d.*?
Anſ. $\frac{8525000}{60000000}$ or $\frac{8525}{60000}$ *l.* or in its loweſt Terms $\frac{517}{3600}$.

CHAP. XXII.

Subtraction of Vulgar Fractions.

THE Rules in *Addition* for reducing the given Fractions to one Denomination, are here to be obſerved; for before Subtraction can be made, the Fractions muſt be reduced to a common Denominator; then ſubtract one Numerator from the other, and place the Remainder over a common Denominator, which Fraction ſhall be the Exceſs or Difference between the given Fractions.

Example.

Queſt. 1. What is the Difference between $\frac{3}{4}$ and $\frac{5}{7}$? The given Fractions are reduced to $\frac{21}{28}$ and $\frac{20}{28}$, then ſubtract

the Numerator 20 from the Numerator 21, and there remains 1, which being put over the Denominator 28 makes $\frac{1}{28}$ for the Answer or Difference between $\frac{3}{4}$ and $\frac{5}{7}$.

Quest. 2. What is the Difference between $\frac{5}{7}$ and $\frac{3}{5}$ of $\frac{5}{8}$?

Reduce the compound Fraction $\frac{3}{5}$ of $\frac{5}{8}$ to a simple Fraction, then proceed as before, and the Answer is $\frac{110}{240}$, equal to $\frac{11}{24}$.

2. When a Fraction is given to be subtracted from a whole Number, subtract the Numerator from the Denominator, and put the Remainder for a Numerator to the given Denominator, and subtract an Unit (for that you borrowed) for the whole Number, and the Remainder place before the Fraction found, as before, which mixed Number is the Remainder or Difference sought.

Example.

Quest. 3. Subtract $\frac{7}{10}$ from 48.

Answer, 47 $\frac{3}{10}$, for if you subtract 7 (the Numerator) from 10 (the Denominator) there remains 3, which put over 10 is $\frac{3}{10}$, and 1 (I borrowed) from 48 rests 47, to which join $\frac{3}{10}$, and it makes 47 $\frac{3}{10}$ for the Excess.

Quest. 4. Subtract $\frac{13}{18}$ from 57, remain 56 $\frac{5}{18}$.

3 If it be required to subtract a Fraction from a mix'd Number, or one mix'd Number from another, reduce the Fraction to a common Denominator, and if the Fraction to be subtracted be lesser than the other, then subtract the lesser Numerator from the greater, and that is a Numerator for the common Denominator; then subtract the lesser integral Part from the greater, and the Remainder, with the remaining Fractions thereunto annexed, is the Difference required between the two given mix'd Numbers.

Quest. 5. Subtract 26 $\frac{3}{7}$ from 54 $\frac{5}{8}$.

First, subtract $\frac{3}{7}$, *viz.* $\frac{18}{42}$ from $\frac{5}{8}$, *viz.* $\frac{35}{42}$, the Remainder is $\frac{17}{42}$; then 26 from 54 remaineth 28, to which annex $\frac{17}{42}$ it makes 28 $\frac{17}{42}$ for the Answer.

4. But if the Fraction to be subtracted is greater than the Fraction from whence you subtract, then having first reduced the Fractions to a common Denominator, take the Numerator of the greatest Fraction out of the Denominator, and add the Remainder to the Numerator of the lesser Fraction, and their Sum is a new Numerator to the common Denominator, which Fraction note; then (for the 1 you borrowed) add 1 to the integral Part to be subtracted, and subtract it from the greater Number, and to the Remainder annex the Fraction you noted before, so this new mix'd Number shall be the Difference sought.

Example

Example.

Queſt. 6. Subtract $14\frac{3}{4}$ from $29\frac{4}{7}$.

The Fractions reduced are, *viz.* $\frac{3}{4}$ equal to $\frac{21}{28}$, and $\frac{4}{7}$ equal to $\frac{16}{28}$; now I ſhould ſubtract $\frac{21}{28}$ from $\frac{16}{28}$, but I cannot, therefore I ſubtract 21 from 28, reſt 7, which added to 16 (the leſſer Numerator) make 23 for a Numerator to 28, *viz.* $\frac{23}{28}$; then I come to the integral Parts 14 and 29, and ſay, I that I borrowed and 14 is 15, which taken from 29 there reſts 14, to which annexing $\frac{23}{28}$, it is $14\frac{23}{28}$, for the Remainder or Difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Queſt. 7. Subtract $36\frac{9}{10}$ from $74\frac{4}{5}$. *Facit* $37\frac{41}{50}$.

CHAP. XXII.

Multiplication of Vulgar Fractions.

1. IF the Multiplicand and Multiplier are ſimple Fractions then multiply the Numerators together for a new Numerator, and the Denominators for a new Denominator, and the new Fraction is the Product required.

Queſt. 1. What is the Product of $\frac{5}{7}$ by $\frac{9}{11}$? *facit* $\frac{45}{77}$; for the Numerators 5 and 9 being multiplied make 45, and the Denominators 7 and 11 being multiplied make 77.

Queſt. 2. What is the Product of $\frac{18}{23}$ by $\frac{21}{37}$? *facit* $\frac{378}{851}$.

2. If the Fractions be multiplied by mix'd Numbers, reduce them to improper Fractions by the firſt Rule of the 19th Chapter, then proceed as before.

Queſt. 3. What is the Product of $48\frac{3}{5}$ by $13\frac{5}{8}$?

The given mix'd Numbers being reduced to improper Fractions are $48\frac{3}{5}$ equal to $\frac{243}{5}$, and $13\frac{5}{8}$ equal to $\frac{83}{6}$; now $\frac{243}{5}$ multiplied by $\frac{83}{6}$, according to the 1ſt Rule of this Chapter, produceth $\frac{20150}{30}$, or $672\frac{9}{30}$.

Queſt. 4. What is the Product of $439\frac{6}{10}$ by $18\frac{3}{7}$? *facit* $8067\frac{4}{70}$ or $8104\frac{14}{70}$.

3. If a compound Fraction is to be multiplied by a ſimple Fraction, firſt reduce the compound Fraction into a ſimple Fraction, then multiply the one by the other, as is taught above.

Queſt. 5. What is the Product of $\frac{16}{21}$ by $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$?

The Compound Fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$ reduced is $\frac{60}{140}$ or $\frac{6}{14}$, which multiplied by $\frac{16}{21}$ produceth $\frac{96}{294}$, which in its loweſt Terms is $\frac{16}{49}$ for the Anſwer.

And if the Multiplicand and Multiplier are both compound Fractions, reduce them both to ſimple ones, then multiply theſe few Fractions as before, ſo you have the Product.

Queſt. 6. What is the Product of $\frac{1}{4}$ of $\frac{2}{3}$ of $\frac{3}{5}$ by $\frac{1}{2}$?
Anſwer $\frac{18}{120}$, in its loweſt Term $\frac{3}{20}$.
Queſt. 7. What is the Product of $\frac{2}{3}$ of $\frac{3}{4}$ by $\frac{3}{8}$ of $\frac{5}{6}$?
Anſwer $\frac{60}{360}$, or $\frac{6}{36}$, or in its leaſt Term $\frac{1}{6}$.

4. If a Fraction be to be multiplied by a whole Number, put under the given whole Number an Unit for a Denominator, whereby it will be an improper Fraction, then multiply the Fractions as before.

Example.

Queſt. 8. What is the Product of 24 by $\frac{2}{3}$?
Anſwer $\frac{48}{3}$; for 24 by putting an Unit under it will be $\frac{24}{1}$, and $\frac{24}{1}$ by $\frac{2}{3}$ produceth $\frac{48}{3}$ or 16.
Queſt. 9. What is the Product of 36 by $\frac{9}{11}$?
Anſwer $3\frac{24}{11}$, or 29 $\frac{5}{11}$.

CHAP. XXIII.

Diviſion of Vulgar Fractions.

1. IF the Dividend and Diviſor are both ſimple Fractions, then multiply the Numerator of the Dividend into the Denominator of the Diviſor, and the Product is a new Numerator, and multiply the Denominator of the Dividend into the Numerator of the Diviſor, and the Product is a new Denominator, which new Fraction thus found is the Quotient you deſire.

Example.

Queſt. 1. What is the Quotient of $\frac{5}{8}$ divided by $\frac{3}{5}$?
Anſ. $\frac{25}{24}$, or $1\frac{1}{24}$; for firſt I multiply (5) the Numerator of the Dividend into (5) the Denominator of the Diviſor, and the Product (25) is a Numerator for the Quotient, then I multiply (8) the Denominator of the Dividend into (3) the Numerator of the Diviſor, and the Product (24) I put in the Quotient for a Denominator; ſo I find $\frac{25}{24}$ is the Quotient ſought.

$$\frac{3}{5}\Big)\frac{5}{8}\Big(\frac{25}{24}$$

Queſt.

Queſt. 2. What is the Quotient of $\frac{10}{21}$ divided by $\frac{2}{3}$?

Anſwer $\frac{30}{42}$, equal to $\frac{5}{7}$ in its loweſt Terms.

2. But if you will divide a ſimple Fraction by a Compound, or a Compound by a ſimple, firſt reduce ſuch Compound to a ſimple Fraction, then go on as before.

Queſt. 3. What is the Quotient of $\frac{3}{10}$ divided by $\frac{3}{4}$ of $\frac{3}{2}$?

Anſwer $\frac{36}{60}$ or $\frac{2}{5}$; firſt reduce $\frac{3}{4}$ of $\frac{2}{3}$ into a ſimple Fraction, and it is $\frac{6}{12}$, by which $\frac{3}{10}$ being divided, the Quotient is $\frac{5}{6}$, equal in its leaſt Terms to $\frac{6}{10}$; and if the Dividend and Diviſor be both of compound Fractions, reduce them both to a ſimple Fraction, then divide the one by the other, as in Rule 1. foregoing.

Queſt. 4. What is the Quote of $\frac{2}{3}$ of $\frac{3}{4}$ divided by $\frac{2}{5}$ of $\frac{5}{6}$?

Anſwer $\frac{180}{120}$ or $\frac{18}{12}$, or $1\frac{6}{12}$, or $1\frac{1}{2}$ in its loweſt Terms.

3. If the Dividend, or Diviſor, or both, are mixed Numbers, reduce them to improper Fractions, and perform Diviſion as you are taught before.

Queſt. 5. What is the Quote of $12\frac{3}{4}$ divided by $21\frac{4}{5}$?

Anſwer $\frac{255}{420}$ for $12\frac{3}{4}$, is equal to $\frac{51}{4}$, and $21\frac{4}{5}$ is equal to $\frac{109}{5}$, and the Quote of $\frac{51}{4}$ divided by $\frac{109}{5}$ is as before $\frac{255}{420}$.

4. If you divide a Fraction by a whole Number, or a whole Number by a Fraction, make the whole Number an improper Fraction, by putting an Unit for a Denominator to it, as was taught in Rule 4. Chap. 22. and then perform Diviſion as was before taught.

Example

Queſt. 6. What is the Quote of 8 divided by $\frac{3}{5}$?

Anſwer $\frac{40}{3}$, which is equal to $13\frac{1}{3}$, being reduced as is before directed. See the Work in the Margent.

$$\begin{array}{r|l} 3 & 8 \\ \hline 5 & 1 \end{array} \quad \left(\begin{array}{l} 40 \text{ or } 13\frac{1}{3}. \end{array}\right.$$

Queſt. 7. What is the Quotient of $\frac{3}{5}$ divided by 8?

Anſwer $\frac{3}{40}$, as *per* Margent.

$$\begin{array}{r|l} 8 & 3 \\ \hline 1 & 5 \end{array} \quad \left(\begin{array}{l} 3 \\ \hline 40 \end{array}\right.$$

CHAP. XXIV.

The Rule of Three Direct in Vulgar Fractions.

AS in the Rule of Three in whole Numbers, ſo likewiſe in Fractions, you muſt ſee that the Fractions of the firſt and third Places be of the ſame Denomination.

2. If any of the given Fractions be compound, let 'em be reduced to ſimple of the ſame Value.

3. If there are given mixed Numbers, reduce them to improper Fractions by the firſt Rule of Chap. 19.

4. If any of the three Terms is a whole Number, make it an improper Fraction, by constituting an Unit for its Denominator.

Having reduced your Fraction as is directed in the four last Rules, then proceed to a Resolution, which is performed the same way as in whole Numbers, Respect being had to the Rule delivered for the working of Fractions, *viz.* Multiply the 2d and 3d Fractions together, according to the first Rule of Chap. 22. and divide the Product by the first Fraction, according to the first Rule of Chap. 23. and the Quotient is the Answer.

Or, (which is better)

5. Multiply the Numerator of the first Fraction into the Denominator of the second and third, and the Product is a new Denominator; then multiply the Denominator of the first Fraction into the Numerator of the second and third, and the Product is a new Numerator, which new Fraction is the fourth Proportional or Answer, which (if it be an improper Fraction) must be reduced to a whole or mix'd Number by the 3d Rule of Chap. 19.

Example.

Quest. 1. If $\frac{3}{4}$ Yards of Cloth cost $\frac{5}{8}$*l.* what will $\frac{2}{10}$ Yards cost?

Having placed the given Fractions according to the 6th Rule of Chap. 10. I proceed to the Resolution, and first I multiply the Numerator of the first Fraction (3) into 8 and 10, the Denominators of the second and third Fractions, and the Product is 240 for a Denominator; then multiply 4 the Denominator of the first Fraction into 5 and 9, the Numerators of the second and third Fractions, the Product is 180 for a Numerator, which Numerator 180 and Denominator 240 make $\frac{180}{240}$*l.* for the Answer, equal to $\frac{3}{4}$ or 15*s.*

Yards	*l.*	*Yards*	*l.*
3	5	9	180
4	8	10	240

l
180 — 3
Facit 240 equal to — 4

Quest. 2. If $\frac{2}{3}$*l.* buy $\frac{5}{6}$ Yards of Cloth, what will $\frac{11}{12}$ Yards cost at that Rate?

Answer $\frac{132}{180}$*l.* equal to $\frac{11}{15}$*l* or 14*s.* 8*d.*

Quest. 3. If $\frac{7}{8}$*l.* cost $\frac{3}{4}$*s.* what will $\frac{8}{9}$ buy?

Answer $\frac{224}{216}$*l.* equal to $1\frac{1}{27}$*l.*

Quest. 4. If $\frac{3}{5}$ of an Ell of Holland cost $\frac{1}{2}$*l.* how much will $12\frac{2}{3}$ Ells cost at that Rate?

Answer $\frac{190}{47}$, equal to $7\frac{21}{47}$*l.*

In resolving the last Question and the two next, observe the 3d Rule of the Chapter foregoing.

Quest. 5. If $\frac{9}{10}$ of a *C.* cost 284*s.* what will $7\frac{1}{2}$*C.* cost at that Rate?

Answer $2366\frac{2}{3}$*s.* or 118*l.* 6*s.* 8*d.*

Quest. 6. If $3\frac{1}{4}$ Yards of Velvet cost $3\frac{5}{8}$*l.* how much will $10\frac{1}{2}$ Yards cost at that Rate?

Answer $11\frac{37}{52}$*l.*

Quest. 7. If 3 Yards of Broad-cloth cost $2\frac{4}{6}$*l.* what will $14\frac{3}{47}$ Yards cost?

Answer 13*l.* 9*s.* 4*d.*

In working the last Question and the four next, observe the 4th Rule of the Chapter foregoing.

Quest. 8. If 14*lb* of Pepper cost 14*s.* $6\frac{3}{4}$*d.* I demand the Price of $73\frac{3}{4}$*lb.*?

Answer 3*l.* 16*s.* $7\frac{43}{56}$*d.*

Quest. 9. If 1*lb* of Cochineel cost 1*l.* 5*s.* what will $36\frac{7}{10}$*lb.* cost?

Answer 45*l.* 17*s.* 6*d.*

Quest. 10. If 1 Yard of Broad-cloth cost $15\frac{5}{8}$*s.* what will 4 Pieces; each containing $27\frac{3}{7}$ Yards cost at that Rate?

Answer 85*l.* 14*s.* $3\frac{3}{7}$*d.*

Quest. 11. A Mercer bought $3\frac{1}{2}$ Pieces of Silk, each Piece contained $24\frac{2}{3}$ Ells, at 6*s.* $0\frac{3}{4}$*d.* *per* Ell, I demand the Value of $3\frac{1}{2}$ Pieces at that Rate?

Answer 26*l.* 3*s.* $\frac{3}{4}$*d.*

In resolving the four next Questions, observe the 8th Rule of Chap. 19.

Quest. 12. If $\frac{2}{5}$ of an Ounce of Silver cost 2*s.* I demand the Price of $11\frac{2}{3}$ at that Rate?

Answer 35*l.*

Quest. 13. If $5\frac{5}{8}$*lb* of Gold is worth 205*l.* 14*s.* $3\frac{3}{7}$*d.* *Sterling*, what is a Grain worth at that Rate?

Answer $1\frac{1}{2}$*d.*

Quest. 14. If $\frac{3}{4}$ Yards of Silk is worth $\frac{3}{4}$ of $\frac{5}{8}$*l.* what is the Price of $15\frac{2}{5}$ Ells Flemish?

Answer 9*l.* 7*s.* 6*d.*

Quest. 15. If $\frac{2}{3}$ of $\frac{3}{4}$ of a Pound of Cloves cost 6*s.* $2\frac{5}{7}$*d.* what cost the C. weight at that Rate?

Answer 69*l.* 6*s.* 8*d.*

Note, That when the Answers to the Questions in this and the next Chapter are given in Fractions, they are given in their lowest Terms.

CHAP.

CHAP. XXV.

The Rule of Three Inverſe in Fractions.

1. IT hath been already taught (in the 3d Rule of the 11th Chapter,) how to diſcover when the 4th Proportional Number (to the 3 given Numbers) is to be found out by a *Rule of Three Direct*, and when by a *Rule of Three Inverſe*, to which Rule the Learner is now referred.

2. When (in Fractions) you find a Queſtion to be reſolved by the *Rule of Three Inverſe, viz.* when the third Term is the Diviſor, then having reduced the Terms exactly (according to the Rules in Chap. 24.) multiply the Numerators of the third Fraction into the Denominators of the ſecond and firſt Fractions, and the Product is a new Denominator; then multiply the Denominator of the third Fraction into the Numerators of the ſecond and firſt Fractions, and the Product is a new Numerator, which new Fraction thus found is the Anſwer to the Queſtion.

Queſt. 1. If $\frac{3}{4}$ of a Yard of Cloth, that is two Yards wide, will make a Garment, how much of any other Drapery that is $\frac{3}{5}$ of a Yard wide will make the ſame Garment?

Anſwer. $2\frac{1}{2}$ Yards.

Queſt. 2. I lent my Friend 46*l.* for $\frac{4}{5}$ of a Year, how much ought he to lend me for $\frac{7}{12}$ Parts of a Year?

Anſwer $6\frac{3}{35}$*l.*

Queſt. 3. If $\frac{2}{3}$ of a Yard of Cloth that is $2\frac{1}{3}$ Yards wide will make any Garment, what Breadth is that Cloth when $1\frac{3}{4}$ Yard will make the ſame Garment?

Anſwer $\frac{56}{63}$ or $\frac{8}{9}$ of a Yard wide?

Queſt. 4. How many Inches in Length of a Board that is 9 Inches broad will make a Foot ſquare?

Anſwer 16 Inches in Length.

Queſt. 5. If when the Buſhel of Wheat coſt $4\frac{3}{4}$*s* the Penny Loaf weighed $10\frac{2}{5}$ Ounces, what will it weigh when the Buſhel coſt $8\frac{0}{10}$*s.*?

Anſwer $5\frac{184}{64}$ Ounces.

Queſt. 6. If 17 Men can mow $24\frac{1}{2}$ Acres in $10\frac{2}{3}$ Days, in how many Days will 6 Men do the ſame?

Anſwer in $21\frac{1}{3}$ Days.

CHAP.

CHAP. XXVI.

Rules of Practice.

1. IN the ſingle Rule of Three, when the firſt of the three Numbers in the Queſtion (after they are diſpoſed according to the 6th Rule of Chap. 10.) happeneth to be an Unit (or 1.) that Queſtion many times may be reſolved far more ſpeedily than by the Rule of Three. which kind of Operation is commonly called *Practice*; and indeed it is of excellent Uſe among Merchants, Tradeſmen and others, by reaſon of its ſpeedineſs in finding a Reſolution to ſuch kind of Queſtions.

2. The chiefeſt Queſtions reſolvable by theſe brief Rules, may be comprehended under the three general Heads or Caſes following, *viz.*

When the given Price of the Integer conſiſts
1. Of Farthings under 4.
2. Of Pence under 12.
3. Of Pence and Farthings.
4. Of Shillings under 20.
5. Of Shillings, Pence and Farthings.
6. Of Pounds.
7. Of Pounds, Shillings, Pence & Farthings.

It would be very convenient for the practical Arithmetician to have by Heart the ſeveral Products of the nine Digits multiplied by 12, for his ſpeedy reducing Pence into Shillings, and Shillings into Pence, which he may gain by the following Table.

12 Times	1	12
	2	24
	3	36
	4	48
	5	60
	6	72
	7	84
	8	96
	9	108

(is)

3. Shillings are practically reduced into Pounds thus, *viz.* cut off the Figure ſtanding in the place of Units with a Daſh of the Pen, and note it for Shillings, then draw a Line under the given Number, and take half the remaining figures (after the firſt is cut off, and ſet them under the Line, and they are ſo many Pounds; but if the laſt Figure is odd, then take the leſſer half, and add 10 to the

Figure

43658

l.	*s.*
2182	18

Figure ſo cutt off (as before) for Shillings; as if I were to reduce 43658 Shillings into Pounds, firſt I cut off the laſt Figure (8) for Shillings, then I take half of the remaining Figures (4365) thus, half of 4 is 2, which I put under the Line, then half of 3 is 1, and becauſe 3 is an odd Number, I make the next Figure 6 to be 16, and I go on, ſaying, half of 16 is 8, then half of 5 is 2, which is the laſt Figure, wherefore, becauſe 5 is an odd Number, I add 10 to the 8 I cut off, and it makes 18*s.* ſo that I find it to be 2182*l.* 18*s.* as *per* Margent.

4. It is likewiſe convenient that the Learner be acquainted with the practical Tables following, the firſt containing the aliquot or even Parts of a Shilling, the ſecond containing the even Parts of a Pound.

The even Part of a Shilling.

	s.
6	$\frac{1}{2}$
4	1
3	$1\frac{1}{2}$
2	2
$1\frac{1}{2}$	$2\frac{1}{2}$
1	3
	$3\frac{1}{2}$
	4
	$4\frac{1}{2}$
	5
	$5\frac{1}{2}$
	6
	$6\frac{1}{2}$
	$\frac{1}{2}$

is

The even Parts of a Pound.

	l.
10 00	$\frac{1}{2}$
6 08	1
5 00	2
4 00	3
3 04	4
2 06	5
2 00	6
1 08	7
1 00	8
	9
	10
	$\frac{1}{20}$

is

Caſe.

5. When the Price of an Integer is a Farthing; then take the 6th Part of the given Number, which will be ſo many Three-half-pences, and if any thing remain it is Farthings, by the 7th Rule of Chap. 9. then conſider, That Three-half-pence is $\frac{1}{8}$ of a Shilling, wherefore take the 8th Part of them for Shillings (and if any thing remain, they are ſo many Three-half-pences,) which reduce into Pounds by the 3d Rule foregoing.

Example.

What comes 67486*lb* to at a Farthing *per lb*? Firſt, I take $\frac{1}{6}$ of 67486, and it is 11247 Three-half-pences, and 4 Farthings or 1 Penny; then $\frac{1}{8}$ of 11247 is 1405*s.* and 7 remains, which is 7 Three-half-pences, or 10$\frac{1}{2}$*d.* which with the 4 Farthings before, make 11$\frac{1}{2}$*d.* and 1405*s.* which by the 3d Rule is 70*l.* 5*s.* in all 70*l.* 5*s.* 11$\frac{1}{2}$*d.* for the Anſwer. See the Work following.

67.

$\frac{1}{6}$	67486 at $\frac{1}{4}$ *per* lb	
	——— ——— *d.*	
$\frac{1}{8}$	11247 ——— 1	
$\frac{1}{20}$	140|5 ——— $11\frac{1}{2}$	
	l. *s.* *d.*	
	70 5 $11\frac{1}{2}$ *facit*	

Other Examples follow.

$\frac{1}{6}$	8576lb at 1*qr.*	
$\frac{1}{8}$	1429 2*qrs.*	
$\frac{1}{20}$	17|8 8*d.*	
	l. *s.* *d.*	
	8 18 $8\frac{1}{2}$	

$\frac{1}{6}$	6380lb at 1*qr.*	
$\frac{1}{8}$	1003 2*qrs.*	
$\frac{1}{20}$	13|2 11*d.*	
	l *s.* *d.*	
	6 12 $11\frac{1}{2}$ *facit*	

6. When the Price of the Integer is two Farthings, then take the third Part of the given Number for so many Three-half-pences, and the Remainder, if any, is Half-pence, then take the eighth Part of that for Shillings, as before, *&c.*

Example

$\frac{1}{3}$	7368lb at 2*qrs.*	
$\frac{1}{8}$	2456	
$\frac{1}{20}$	3017	
	l. *s.*	
	15 7	

$\frac{1}{3}$	8247lb at 2*qrs.*	
$\frac{1}{8}$	2782 2*qrs.*	
$\frac{1}{20}$	34|7 9*d.* $\frac{1}{2}$	
	l. *s* *d.*	
	17 7 $9\frac{1}{2}$ *facit*	

7. When the Price of the Integer is 3 Farthings, then take half the given Number for Three-half-pence, and if any Thing remain it is 3 Farthings; then take the 8th for Shillings, as before, *&c.*

$\frac{1}{2}$	4736lb at 3*qrs.*	
$\frac{1}{8}$	2368	
$\frac{1}{20}$	9|6	
	l. *s.*	
	14 16 *facit*	

$\frac{1}{2}$	4253lb at 3*qrs.*	
$\frac{1}{8}$	2126 3*q*	
$\frac{1}{20}$	53|9 3*qrs.*	
	l. *s.* *d.* *qrs.*	
	26 19 0 3 *facit*	

Case 2.

8. When the given Price of the Integer is a Part or Parts of a Shilling, (*viz.* Pence) divide the given Number of Integers (whose Value is sought) by the Denominator of the Fraction, representing the even Part, and the Quote is Shillings (always minding the 7th Rule of the 9th Chapter) and those Shillings may be reduced into Pounds by the 3d Rule of

of this Chapter. *Example.* Let it be required to find th Value of 438 *lb* at 3*d. per lb* I conſider 3*d.* is ¼ of a Shi ling, and 438*lb* will coſt ſo many 3 Pences, wherefore I di vide 438 by 4, the Denominator of ¼, and the Quotie 109 Shillings, and 2 remains, which is two 3*d.* or 6*d.* th whole Value is 5*l.* 9*s.* 6*d.* as by the following Work ap peareth.

		l.	*s.*
¼	438*l.* at 3*d.*		
1/20	109--- 6*d.*	*Facit* 5	9

More Examples follow.

	lb. *d.*		*lb.* *d.*
½	3574 at 6 *per* l.	1/6	5316 at 2 *per* l.
1/20	178|7	1/20	88|6
	89*l.* 7*s. facit*		44*l.* 6*s. facit*
	lb. *d.*		*lb.* *d.*
⅓	438 at 4 *per* l.	⅛	6389 at 1½ *per* l.
1/20	146	1/80	79|8 7*d.* ½
	7*l.* 6*s. facit*		39*l.* 18*s.* 7½*d.*
	lb. *d.*		*lb.* *d.*
¼	879 at 3 *per* l.	1/12	818 at 1 *per* l.
1/20	219 9*d.*	20	6|8 2
	10*l.* 19*s.* 9*d.*		3*l.* 8*s.* 2*d. facit*

If the Learner is minded to try the Fruitfulneſs of hi Genius, he may frame as many Examples as he thinks fi and work them as before

9. If the Price of the Integer be Pence under 12, and yet not an even Part, then it may be divided into even Parts, and ſo the Parts of the given Numbers taken ac cordingly and added together; as if it were 5*d.* which i 3*d.* and 2*d. viz.* ¼ and ⅙ of a Shilling, firſt take ¼ of th given Number, and then ⅙ thereof, and add them together and their ſum is the Anſwer in Shillings, ſtill obſervin Rule 7. of Chap. 9. for the Remainder, (if any be) the bring the Shillings into pounds, by the 3d Rule foregoing Likewiſe 7*d.* is ⅓ and ¼, ſo 9*d.* is ½ and ¼, and 10*d.* is ½ an ⅓, and 11*d.* is ½ and ⅓ and ¼ of a Shilling; or elſe many Times your Work may be ſhortened thus, *viz.* when th ſaid given Price is to be divided into even Parts of a Shi ling, or of a Pound, after you have taken the firſt eve Part, the other may be an even Part of that Part, as in th next Example, where is given 439*lb* at 5*d. per lb* now I ma divi

divide it thus, *viz.* into 4*d.* and 1*d.* and 4*d.* being $\frac{1}{3}$ of a Shilling, and 1*d.* being $\frac{1}{4}$ of 4*d.* I firſt take $\frac{1}{3}$ of 439*l.* and it gives 146*s.* 4*d.* and for the 1*d* I take $\frac{1}{4}$ of 146*s.* 4*d.* which is 36*s.* 7*d.* which in all come to 9*l.* 2*s.* 11*d.* Examples follow.

	l.	*d.*
	439 at 6 *per* l.	
$\frac{1}{3}$	146	4
$\frac{1}{4}$	36	7
	18|2	11
	9*l.* 2*s.* 11*d. facit*	

	Ells	*d.*
	587 at 7 *per* Ell	
$\frac{1}{3}$	195	8
$\frac{1}{4}$	146	9
	34 2	5
	17*l.* 2*s* 5*d. facit*	

	yds.	*d.*
	836 at 8 *per* yd.	
$\frac{1}{3}$	278	8
$\frac{1}{3}$	278	8
	55|7	4
	27*l.* 17*s.* 4*d. facit*	

	yds.	*d.*
	417 at 9 *per* yd.	
$\frac{1}{2}$	208	6
$\frac{1}{2}$	104	3
$\frac{1}{20}$	31|2	9
	15*l.* 12*s.* 9*d. facit*	

	Ells	*d.*
	386 at 10	
$\frac{1}{2}$	193	
$\frac{1}{3}$	128	8
	32|1	8
	16*l.* 1*s.* 8*d. facit*	

	l.	*d.*
	534 at 11	
$\frac{1}{3}$	178	
$\frac{1}{3}$	178	
$\frac{1}{4}$	133	6
	48|9	6
	24*l.* 9*s.* 6*d. facit*	

10 When the Price of the Integer is Pence and Farthings, if it make an even Part of a Shilling, work as before; but if they are uneven, as Penny Farthing, Penny three Farthings, 2*d.* 1*qr.* or 2*d.* 3*qrs.* 3*d.* 3*qrs.* or the like, then firſt work for ſome even Part, and then conſider what Part the reſt is of that even Part and divide that Quotient thereby, then add them together, and reduce them to Pounds as before. *Example,* 3470*lb* at 1*d.* 1*qr. per lb*; firſt I work for the Penny by dividing 3470*lb* by 12, for 1*d*, is $\frac{1}{12}$ of a Shilling, and the Quote is 289*s.* 2*d.* then I conceive that one Farthing is the $\frac{1}{4}$ of a Penny, and the Value at one Farthing will be $\frac{1}{4}$ of the Value at a Penny, and therefore I take $\frac{1}{4}$ of 289*s.* 2*d.* which is 72*s.* 3*d.* 2*qrs* and add them together, and they are 18*l.* 1*s.* 5*d.* 2*qrs.* as by the Margent.

	l.	*d. qr.*
	3470 at 1	1
$\frac{1}{12}$	289	2
$\frac{1}{4}$	72	3 2
$\frac{1}{20}$	36|1	5 2
	l. *s.*	*d. qrs.*
	18 1	5 2

	lb.	*d.*
$7\frac{1}{2}$	4360 at	$1\frac{1}{4}$
$\frac{1}{4}$	363	4
	90	10
	454	2

22l. 14s. 2d. facit

	485*lb.* at	$2\frac{1}{4}d.$
$\frac{1}{8}$	80	10
$\frac{1}{16}$	10	$1\frac{1}{4}$
	90	$11\frac{1}{4}$

4l. 10s. $11\frac{1}{4}d.$ facit

	654*lb.* at	$2\frac{1}{2}d.$
$\frac{1}{8}$	109	
$\frac{1}{4}$	27	3*d.*
	136	

6l. 16s. 3d. facit

	yds.	*d.*
	573 at	$1\frac{3}{4}$
$\frac{1}{8}$	71	$7\frac{1}{4}$
$\frac{1}{16}$	11	$11\frac{1}{4}$
	813	$6\frac{3}{4}$

4l. 3s. $6\frac{3}{4}d.$ facit

	520*yds.* at	$7\frac{1}{2}l.$
$\frac{1}{2}$	260	
$\frac{1}{4}$	65	
$\frac{1}{20}$	325	

16l. 5s. facit

	137*yds.* at	$10\frac{1}{2}d.$
$\frac{1}{2}$	68	6*d.*
$\frac{1}{2}$	34	3
$\frac{1}{2}$	17	$1\frac{1}{2}$
$\frac{1}{10}$	1119	$10\frac{1}{2}d.$

5l. 19s. $10\frac{1}{2}d.$ facit

Case 4

11. When the Price of the Integer is 2*s.* then cut off the Figure in the Place of Units of the given Number, and double it for Shillings, and the Figures on the other hand are Pounds. *Example.* 436 Yards at 2*s. per* Yard; cut off the last Figure 6, and double it, it makes 12*s.* and the two other Figures, *viz.* 43. are so many Pounds; so that their Value is 43*l.* 12*s.* as *per* Margent.

436 — 43*l.* 12*s.*

12. Hence it is evident, that when the given Price of an Integer is an even Number of Shillings, then if you take half of that (even Number of Shillings) and multiply the given Number of Integers thereby, doubling the First Figure of the Product and setting it apart for Shillings, the rest of the Product will be Pounds, which Pounds and Shillings are the Value sought. *Example.* What cost 536 Yards at 8*s. per* Yard? To resolve which, I take half of 8*s.* (the Price of a Yard) which is 4, and multiply 536 thereby, saying, 4 times 6 is 24, then I double the first Figure 4 makes 8 for Shillings, and carry 2 to the next Product, *&c.* I find the rest of the Product to be 214, which I note for Pounds; so that the Value of 536 Yards at 8*s. per* Yard, is 214*l.* 8*s.* as by the Margent. Other Examples of the same Kind may be wrought after the same Manner.

536 *yds.* at	4
214*l.* 8*s.*	

56 *yds.* at 6*s.* *per* yard	420 *yds.* at 12*s.* *per* yd.
16*l.* 16*s.* *facit*	252*l.* *facit*
123 *yds.* at 4*s.* *per* yard	326 *yds.* at 14*s.* *per* yd.
24*l.* 12*s.* *facit*	228*l.* 4*s.* *facit*
48 *Ells* at 8*s.* *per* Ell	48 *yds.* at 16*s.* *per* yard
19*l.* 4*s.* *facit*	38*l.* 8*s.* *facit*
84 *yds.* at 10*s.* *per* yard	52 *yds* at 18*s.* *per* yard
42*l.* *facit*	46*l.* 16*s.* *facit*

13. If the given Price of the Integer is an odd Number of Shillings, then work first for the even Number of Shillings, by the last Rule, and for the odd Shilling take $\frac{1}{20}$ of the given Number of Integers, according to the 3d Rule of this Chapter, and add them together, and you have your Desire. Examples follow.

Yds. *s.*	*Ells* *s.*
422 at 3 *per* Yard	431 at 13
l. *s.*	*l.* *s.*
42 4	258 12
21 2	21 11
63 0 *facit*	280 03 *facit*
Ells *s.*	*Ells* *s.*
516 at 7 *per* Ell	724 at 17 *per* Ell
l. *s.*	*l.* *s.*
154 16	259 04
25 16	16 04
180 12 *facit*	275 08 *facit*

14. Except when the given Price of the Integer is 5*s.* for then it is sooner answered by taking $\frac{1}{4}$ of the given Number whose Value is sought, as in the following Example.

$\frac{1}{4}$	*Yds.* *s.*
	436 at 5 *per* Yard
	109*l.* *facit*

$\frac{1}{4}$	*Ells* *s.*
	206 at 5 *per* Ell
	51*l.* 10*s.* *facit*

Case 5.

15. When the given Price of an Integer is Shillings and Pence, *&c.* making an even Part of a Pound, then divide the given Number of Integers, whose Value you seek, by the Denominator of that Fraction representing that even Part. As for Example. What is the Price of 384 Yards at 6*s.* 8*d.* *per* Yard? Here I consider that 6*s.* 8*d.* is $\frac{1}{3}$ of a Pound, wherefore divide 384 by 3, and the Quote is the Answer, *viz.* 128*l.* so that 384 Yards at 6*s.* 8*d.* *per* Yard, amount to 128*l.* as *per* Margent, still observing the 7th Rule of the 9th Chapter.

$\frac{1}{3}$	384
	128*l.* *facit*

More Examples follow.

1/3	438 *Ells* at 6*s.* 8*d.*		1/8	443 *Yards* at 2*s.* 6*d.*	
	146*l. facit*			55*l.* 7*s.* 6*d. facit*	
1/6	525 at 3*s.* 4*d.*		1/2	726 *Yards* at 1*s.* 8*d.*	
	87*l.* 10*s. facit*			60*l.* 10*s. facit*	

16. When the given Value of the Integer is Shillings and Pence, and not an even Part of a Pound, yet many times it may be divided into Parts, (*viz.* 6*s.* 6*d* is 4*s.* and 2*s.* 6*d.*) For the 4*s.* work according to the 12th Rule foregoing, and for the 2*s.* 6*d.* take the eighth Part of the given Number, and add them together, then their Sum is the Value required.

So 8*s.* 6*d.* will be divided into 6*s.* and 2*s.* 6*d.* and the Price of the given Number may be found out as before, &c. Examples follow.

	yds.	*s.*	*d.*		*Ells*	*s.*	*d.*
1/3	386 at	8	8	*s.*	427 at	8	6
	128*l.*	13	4	6	128*l.*	2	0
1/16	38	12	0	1/8	53	7	6
	167*l.*	5*s.*	4*d. facit*		181*l.*	9*s.*	6*d. facit*
	Ells	*s*	*d.*		*yds.*	*s.*	*d.*
s.	540 at	5	4	*s.*	386 at	14	8
2	54	0		8	154*l.*	8	0
1/6	90	0		1/3	128	13	4
	144*l. facit*				283*l.*	1*s.*	4*d. facit*

17. When the given Price of an Integer is Shillings and Pence, and you cannot readily divide them according to the last Rule, then multiply the given Number whose Value you seek, by the Number of Shillings in the Price of the Integer, and then for the Pence work by the 8th Rule foregoing; then add the Numbers together, and their Sum is their Value sought in Shillings; as for Example. What is the Value of 392 Yards at 6*s.* 9*d. per* Yard. Here 6*s.* 9*d.* cannot be made an even Part, nor indeed can it be divided into even Parts of a Pound; wherefore I multiply the given Number of Yards 392 by 6 for the 6*s.* the Product is 2352*s.* then for the 9*d.* I divide it into 6*d.* and 3*d.* and work for them by the 8th Rule foregoing, and at last add the Shillings together, they make 2646*s.* and by the third they are reduced to 132*l.* 6*s.* the Value of 392 Yards at 6*s.* 9*d. per* Yard. See the Work.

		392 *yds.* at 6*s.* 9*d.*
		2352
	½	196
	¼	98
		2646
		132*l.* 6*s. facit*

Other Examples follow.

		lb.	*s.*	*d.*
		480 at	4	10
d	*s.*	4		
6	4	1920		
4	½	240		
	⅓	160		
		2320		
		116*l. facit*		

	Ells	*s.*	*d.*
	732 at	12	7
	12		
12	8784		
4⅓	244		
3¼	2183		
	9211		
	460*l.* 11*s. facit*		

In like manner may Variety of other Examples be wrought.

18. When the given Price of the Integer is Shillings, Pence and Farthings, then multiply the given Number of Integers, by the Numbers of Shillings contained in the Value of the Integer, and for the Pence and Farthings follow the 10th Rule of this Chapter.

Example.

	Ells	*s.*	*d.*
	438 at	8	6¾
s.			
8	3504		
½	219		
⅛	27		4½
	3751	0	4½
	Fac. 187*l.* 10*s.* 4½*d.*		

	Ells	*s.*	*d.*
	136 at	9	2¼
s.			
9	1224	0	
½	22	8	
¼	5	8	
	1251	4	
	Fac. 62*l.* 12*s.* 4*d.*		

	Ells	*s.*	*d.*
	370 at	14	2¾
	1480		
s.	370		
14	5180		*d.*
⅙	61	8	
¼	15	5	
½	7	8½	
	5263	4	9½
	Fac. 263*l.* 4*s.* 9½*d.*		

	Ells	*s.*	*d.*
	431 at	2	4½
2	862		
½	107	6	
⅛	53	10½	
	1023		7½
	Fac. 51*l.* 3*s.* 7½		

Case 6.

19. When the give Value of the Integer is Pounds, then multiply the Number of Integers, whole Value is sought, by the Price of the Integer, and the Product is the Answer in Pounds.

Examples.

C.	l.		C.	l.
42 at 2 *per* C.			13 at 8 *per* C.	
84*l. facit*			104*l. facit*	
C.	l.		C.	l.
30 at 3 *per* C			48 at 12 *per* C	
90*l. facit*			576*l. facit*	

Case 7.

20. If the Price of the Integer is Pounds and Shillings, hen for the Pounds work as in the last Rule, and for the Shillings as in the 12th and 13th Rules foregoing; then add the Numbers produced from them both, and the Sum the Value sought.

Examples.

	C.	l.	s.
	46 at	2	4
2*l.*	92	*s.*	
4*s.*	9	4	
	101	4	

	Gross	l.	s.
	58 at	3	7
3*l.*	174	*s.*	
6*s.*	17	8	
1*s.*	2	18	
	194*l.*	0*s.*	*facit*

	Gross	l.	s.
	82 at	4	10
4*l.*	328		
10*s.*	41		
	369*l. facit*		

	Gross	l.	s.
	26 at	3	15
3*l*	78		
14*s.*	18	4	
1*s.*	1	6	
	97*l.*	10*s.*	*facit*

21. When the given Price of an Integer consists of Pounds Shillings, Pence and Farthings, then work for the Shillings, Pence, and Farthings, according to the 18th Rule of this Chapter, and find the total Value of the given Number as if there were no Pounds, then work with the Pounds, according to the 19th Rule of this Chapter, and add the Numbers thus found, and their Sum is the total Value required.

Examples

Examples of this Rule follow.

	C.	l.	s.	d.
	213 at	1	13	$4\frac{1}{2}$
	639			
	213			
13*s.*	2769		*d.*	
3*d.*	53		3	
$1\frac{1}{2}$*d.*	26		$7\frac{1}{2}$	
	28418		$10\frac{1}{2}$	
	142*l.* 08*s.* $10\frac{1}{2}$*d.*			
1*l.*	213			
	355*l.* 08*s.* $10\frac{1}{2}$*l. facit*			

	Grofs	*l.*	*s.*	*d.*
	416 at	2	9	$3\frac{3}{4}$
9*s.*	3744			
3*d.*	104			
$\frac{1}{4}$*d.*	26			
	38714			
	193*l.* 14*s.*			
2*l.*	832			
	1025*l.* 14*s. facit*			

	C	*l.*	*s.*	*d*
	37 at	3	8	$10\frac{1}{2}$
296	*d.*		8*s.*	
18	6		6*d.*	
9	3		3*d.*	
4	$7\frac{1}{2}$		$1\frac{1}{2}$*d.*	
328	$4\frac{1}{2}$			
16*l.* 8*s* $4\frac{1}{2}$*d.*				
111			3*l.*	
127*l.* 8*s.* $4\frac{1}{2}$*d. facit*				

	Grofs	*l.*	*s.*	*d.*
	48 at	3	15	$11\frac{1}{2}$
240				
48				
720			15*s.*	
24			6*d.*	
16			4*d.*	
6			$1\frac{1}{2}$*d.*	
7616				
38 6				
144			3*l.*	
182*l.* 6*s facit*				

22. When there is given the Value of an Integer, and it is required to know the Value of many such Integers together, with $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ of an Integer, then first (by the former Rules) find out the Value of the given Number of Integers, and then for $\frac{1}{4}$ of an Integer, take $\frac{1}{4}$ of the given Value of the Integer, or for $\frac{1}{2}$ take $\frac{1}{2}$ of the given Value of the Integer; and for $\frac{3}{4}$ first take the half of the given Value, and then half of that half, setting each Part under the Precedent, then adding them together, their Sum will be the required Value of the Integers and their Parts.

Example.

What is the Value of $116\frac{1}{2}$ Yards, at 4*s.* 6*d per* Yard? To give an Answer; first, I work for the Value of 116 Yards, by the 15th Rule foregoing, and then for the half Yard, I take half of 4*s.* 6*d.* which is 2*s.* 3*d.* and add to the rest found as before, then is that Sum the total Value of $116\frac{1}{2}$ Yards at 4*s.* 6*d. per* Yard, which I find to amount to 26*l.* 4*s.* 3*d.* as by the Work in the Margent. And all other Examples of this Kind are wrought the same Way.

yds.	*s.*	*d.*
$116\frac{1}{2}$ at	4	6
116*l.* 12*s.*	2*s.*	
4*l.* 10*s.*	2*s* 6*d.*	
213	$\frac{1}{2}$ *Yards*	
26*l.* 4*s* 3*d facit*		

Other Examples follow.

$324\frac{1}{4}$ *yds.* at 4*s.* 10*d.*

1296	4*s.*
162	6*d.* $\frac{1}{2}$
108	4*l.* $\frac{1}{3}$
1 $2\frac{1}{2}$*d.*	$\frac{1}{4}$ *yd.*

156 7*s.* $2\frac{1}{2}$*d.*

78*l.* 7*s.* $2\frac{1}{2}$*d. facit*

$228\frac{3}{4}$ *Ells* at 12*s.* 11*d.*

2736	12*s.*
76	4*d.* $\frac{1}{3}$
76	4*d.* $\frac{1}{3}$
57	3*d.* $\frac{1}{4}$
6 $5\frac{1}{2}$*d.*	$\frac{1}{4}$ *Ell*
3 $2\frac{3}{4}$*d.*	$\frac{3}{4}$ *Ell*

295|4 $8\frac{1}{4}$*d.*

147*l.* 14*s.* $8\frac{1}{4}$*d. facit*

$720\frac{1}{2}$ *yds.* at 6*s* 8*d.*

240*l.* 3*s.* 4*d. facit*

C.	*qrs.*	*lb*	*l.*	*s.*
28	3	14	at 1	10

28*l.*		1*l.*
14		10$\frac{1}{2}$
	15*s.*	$\frac{1}{2}$ *C.*
	7*s.* 6*d.*	$\frac{1}{4}$ *C.*
	3*s* 9*d.*	14*l.*

43*l.* 6*s.* 3*d. facit*

Many more Queſtions may be ſtated, and ſeveral other Rules of Practice may be ſhewn, according to the Methods of diverſe Authors, but what have been delivered here are ſufficient for the practical Arithmetician in all Caſes whatſoever.

CHAP. XXVII.

Barter.

1. BARTER is a Rule among Merchants, which (in the Exchange of one Commodity for another) informs them ſo to proportion their Rates as that neither may ſuſtain Loſs.

2. To reſolve Queſtions in *Barter*, will not be difficult to him that is acquainted with the *Golden Rule* or *Rule of Three*, it being altogether uſed in reſolving ſuch Queſtions.

Queſt. 1. Two Merchants (*viz. A* and *B*) barter, *A* hath 13*C.* 3*qrs.* 14*lb* of Pepper, at 2*l.* 16*s. per* C. and *B* hath Cotton at 9*d. per lb* I demand how much Cotton *B* muſt give *A* for his Pepper?

Anſ. 9*C.* 1*qr.*

Firſt find by the *Rule of Three*, or the Rules of *Practice* foregoing, how much the Pepper is worth, ſaying, if 1*C.* coſt 2*l.* 16*s.* what will 13*C.* 3*qrs.* 14*lb* coſt?

Anſwer 38*l.* 17*s.*

Secondly, by the *Rule of Three*, ſay if 9*d.* buy 1*lb* of Cotton, how much will 38*l.* 17*s.* buy?

Anſwer. $9\frac{1}{4}$*C.* and ſo much Cotton muſt *B* give to *A* for 13*C.*

3C. 3qrs. 14lb of Pepper, at 2l. 16s. *per* C. when the Cotton is worth 9d. *per* lb.

Queſt. 2. *A* and *B* barter, *A* hath 120 Yards of Broadcloth worth 6s. *per* Yard, but in the Barter he will have 8s. *per* Yard; *B* hath Shalloon worth 4s. *per* Yard. Now I demand how many Yards of Shalloon *B* muſt give *A* for his Broadcloth, making his Gain in Barter equal to that of *A*?

Anſwer 180 Yards of Shalloon.

Firſt (as in the laſt Queſtion) find out how *B* ought to ſell his Shalloon in Barter, *viz.* ſay if 6s. require 8s. what will 4s. require?

Anſwer 5s. 4d.

Thus you ſee that *B* muſt ſell his Shalloon in Barter at 5s. 4d. if *A* ſell his Broadcloth at 8s. *per* Yard.

It remaineth now to find out how much Shalloon *B* muſt give for 120 Yards of Broadcloth; which reſolved after the Method in the firſt Queſtion of this Chapter, is found to be 180, and ſo many Yards of Shalloon muſt *B* give *A* for the 120 Yards of Broadcloth

Queſt. 3 *A* and *B* bartered, *A* had 14C. of Sugar, worth 6d. *per* lb, for which *B* gave him 1C. 3qrs. of Cinnamon; I demand how *B* rated his Cinnamon per lb?

Anſwer 4s. *per* lb.

Queſt. 4. *A* and *B* barter, *A* hath 4 Tun of Brandy, worth 37l. 16s. ready Money, but in Barter he hath 30l. 8s. *per* Tun, and *B* giveth 21C. 2qrs. 11½lb of Ginger for the 4 Tun of Brandy; I deſire to know how much *B* ſold his Ginger for in Barter *per* C. and how much it is worth in ready Money?

Anſwer for 9l. 6s. 8d. in Barter, and it is worth 7l. *per* C. in ready Money.

Queſt. 5. *A* and *B* barter, *A* hath 320 Dozen of Candles at 4s. 6d. *per* Dozen, for which *B* giveth him 30l. in Money, and the reſt in Cotton at 8d. *per* lb; I demand how much Cotton he muſt give him more than the 30l.

Anſwer 11C. 1qr.

CHAP. XXVIII.

Queſtions in Loſs and Gain.

1 A Merchant bought 436 Yards of Broadcloth for 8s. 6d. *per* Yard, and ſelleth it again at 10s. 4d. *per* Yard; now I deſire to know how much he gained in the ſale of the 436 Yards? *Anſwer* 39l. 19s. 4d.

Firſt,

Firſt, find out by the *Rule of Three*, or by *Practice*, how much the Cloth coſt him at 8*s*. 6*d*. *per* Yard, which I find to be 185*l*. 6*s*. then by the ſame Rule find out how much he ſold it for, *viz*. 225*l*. 5*s*. 4*d*. then ſubtract 185*l*. 6*s*. which it coſt him, from 225*l*. 5*s*. 4*d*. which he ſold it for, and there remaineth 39*l*. 19*s*. 4*d*. for his Gain in the Sale thereof.

Otherwiſe, it may ſooner be reſolved thus; firſt find out how much he gained *per* Yard, *viz*. ſubtract 8*s*. 6*d*. which he gave *per* Yard. from 10*s*. 4*d*. which he ſold it for *per* Yard, the Remainder is 1*s*. 10*d*. for his Gain *per* Yard. Then ſay,

If 1 Yard gain 1*s*. 10*d*. what will 436 Yards gain? The Anſwer by *Practice* or the *Rule of Three*, is 39*l*. 19*s*. 4*d*. as was found before.

Queſt. 2. A Draper bought 124 Yards of Holland Cloth for which he gave 31*l*. I deſire to know how he muſt ſell it *per* Yard to gain 10*l*. 6*s*. 8*d*. in the whole Sale of 124 Yards?

Anſwer at 6*s*. 8*d*. *per* Yard.

Add the Price which it coſt him (*viz*. 31*l*.) to his intended Gain, (*viz*. 10*l*. 6*s*. 8*d*.) the Sum is 41*l*. 6*s*. 8*d*. Then ſay,

If 124 Yards require 41*l*. 6*s*. 8*d*. what will 1 Yard require? By the *Rule of three* I find the Anſwer to be 6*s*. 8*d*.

Queſt. 3. A Grocer bought 3*C*. 1*qr*. 14*lb* of Cloves which coſt him 2*s*. 4*d*. *per lb*, and ſold them for 52*l*. 14*s*. I deſire to know how much he gained in the whole?

Anſwer 8*l*. 12*s*.

Queſt. 4. A Draper bought 86 Kerſeys for 129*l*. I demand how he muſt ſell them *per* Piece to gain 15*l*. in laying out 100*l*. at that Rate?

Anſwer 1*l*. 14*s*. 6*d*. *per* Piece; for,

As 100*l*. is to 115*l*. ſo is 129*l*. to 148*l*. 7*s*.

So that, by the Proportion above, I have found how much he muſt receive for the 86 Kerſeys, to gain after the Rate of 15 *per Cent*. Then to find how he muſt ſell them *per* Piece, I ſay,

As 86 Pieces are to 148*l*. 7*s*. ſo is 1 Piece to 1*l*. 14*s*. 6*d*. which is the Number ſought.

Queſt. 5. A Grocer bought 4$\frac{1}{2}$*C*. of Pepper for 15*l*. 17*s*. 4*d*. and (it proving to be damnified) is willing to loſe 12*l*. 10*s*. *per Cent*. I demand how he muſt ſell it *per lb*?

Anſwer 7*d*. *per lb*.

Subtract 12*l*. 10*s*. the Loſs of 100*l*. from 100*l*. and there remains 87*l*. 10*s*. Then ſay,

As 100*l.* is to 87*l.* 10*s.* ſo is 15*l.* 17*s.* 4*d.* to 13*l.* 17*s.* 8*d.* and ſo much he muſt ſell it all for, to loſe after the Rate propounded. Then to know how he muſt ſell it *per lb* I ſay,

As 4½ *C.* is to 13*l.* 17*s.* 6*d.* ſo is 1*lb* to 7*d.*

Queſt. 6. A Plummer ſold 10 Fodder of Lead (the Fodder containing 19½ *C.*) for 204*l.* 15*s.* and gained after the Rate of 12*l.* 10*s.* *per* 100*l.* I demand how much it coſt him *per C?*

Anſwer 18*s.* 8*d.*

To reſolve this Queſtion, add 12*l.* 10*s.* (the Gain *per Cent*) to 100*l.* and it makes 112*l.* 10*s.* Then ſay,

As 112*l.* 10*s.* is to 100*l.* ſo is 204*l.* 15*s.* to 182*l.* which 182*l.* is the Sum it coſt him in all; then reduce your 10 Fodders to Half Hundreds, and it makes 390. Then ſay,

As 390 Half Hundreds is to 182*l.* ſo is 2 Half Hundreds to 18*s.* 8*d.* the Price of 2 Half Hundreds, or 1 *Cwt.* and ſo much it ſtood him in *per Cwt.*

Queſt. 7. A Merchant bought eight Tuns of Wine, which, being ſophiſticated, he ſelleth for 400*l.* and loſeth after the Rate of 12*l.* in receiving 100*l.* Now I demand how much it coſt him *per* Tun, and how he ſelleth it *per* Gallon to loſe after the ſaid Rate?

Anſw. It coſt him 56*l. per* Tun, and he muſt ſell it at 3*s.* 11*d.* 2$\frac{10}{21}$*rs* Gallon, to loſe 12*l.* in receiving 100*l.*

To reſolve this Queſtion, I conſider, in the firſt Place, that in receiving 100*l.* he loſeth 12*l.* therefore 100*l.* comes in for 112*l.* laid out; wherefore, to find out how much he laid out for the whole, I ſay,

As 100*l.* is to 112*l.* ſo is 400 to 448*l.* and ſo much the 8 Tun coſt him. Then to find out how much it coſt *per* Tun, I ſay,

As 8 is to 448*l.* ſo is 1 to 56*l.* the Price it coſt *per* Tun.

Now to find how he muſt ſell it *per* Gallon, reduce the 8 Tuns into Gallons, they make 2016. Then ſay,

As 2016 Gallons is to 400*l.* ſo is 1 Gallon to 3*s.* 11*d.* $\frac{10}{21}$*rs.* the Price he muſt ſell it at *per* Gallon to loſe as foreſaid.

Queſt. 8. A Merchant bought 8 Tun of Wine, which being ſophiſticated he is willing to ſell for 400*l.* and loſeth at that Rate 12*l.* in laying out 100*l.* upon the ſame; now I demand how much it coſt him *per* Tun?

Here I conſider, that for 100*l.* laid out he received but 88*l.* wherefore to find what 8 Tuns coſt him, I ſay,

As 88*l.* is to 190*l.* ſo is 400*l.* to 454$\frac{6}{11}$*l.* the Price it all coſt him. Then to find out how much *per* Tun, I ſay,

As 8 is to 454$\frac{6}{11}$, ſo is 1 to 56$\frac{8}{11}$, or 56*l.* 16*s.* 4*d.* 1$\frac{6}{11}$*qrs.* *per* Tun.

CHAP.

CHAP. XXIX.

Equation of Payments.

1. EQUATION of Payments, is that Rule among Merchants, whereby we reduce the Times for Payment of ſeveral Sums of Money, to an equated Time for Payment of the whole Debt, without Damage to Debtor or Creditor; and

The Rule is

2. Multiply the Sum of each particular Payment by its reſpective Time, then add the ſeveral Products together, and their ſum divide by the total Debt, and the Quotient thence ariſing is the equated Time for the Payment of the whole Debt.

Example.

Queſt. 1. *A* is indebted to *B* in the Sum of 130*l.* whereof 50*l.* is to be paid at 2 Months, and 50*l.* at 4 Months, and the reſt at 6 Months; now they agree to make one Payment of the total Sum: The Queſtion is, what is the equated Time for Payment, without Damage to Debtor or Creditor?

To reſolve this Queſtion, I multiply each Payment by its Time, *viz.*

50*l.* multiplied by 2 Months produceth	100
50*l.* multiplied by 4 Months produceth	200
30*l.* multiplied by 6 Months produceth	180
The ſum of the Products is	480

Then I divide 480 (the Sum of the Products) by 130 (the total Debt) and the Quotient is $3\frac{9}{13}$ Months for the Time of paying the whole Debt.

Queſt. 2. A Merchant hath owing to him 1000*l.* to be paid as followeth, *viz.* 600*l.* at 4 Months, 200*l.* at 6 Months, and the reſt (which is 200*l.* at 12 Months,) and he agreeth with the Debtor to make one payment of the whole; I demand the Time of Payment without Damage to Debtor or Creditor?

600*l.* multiplied by	4 Months is	2400
200*l.* multiplied by	6 Months is	1200
200*l.* multiplied by	12 Months is	2400
The Sum of the Products is		6000

and the Sum of the Products (6000) being divided by the whole Debt (1000*l.*) quotes 6 Months for the Time of Payment of the whole Debt.

3. The

3. The Truth of the Rule is thus manifeſt, if the Intereſt of that Money which is paid by the equated Time (after it is due) be equal to the Intereſt of that Money which (by the equated Time) is paid ſo much ſooner than it is due at any Rate *per Cent.* then the Operation is true, otherwiſe not.

The Proof of the Rule of Equation of Payments.

Example.

In the laſt Queſtion 600*l.* ſhould have been paid at 4 Months, but it is not diſcharged till 6 Months (that is 2 Months after it is all due) wherefore its Intereſt for 2 Months at 6 *per cent. per annum* is 6*l.* and then 200*l.* was to be paid at 6 Months, which is the equated Time for its Payment, therefore no Intereſt is reckoned for it, but 200*l.* ſhould have been paid at 12 Months, but it is paid at 6 Months, which is 6 Months ſooner than it ought, wherefore the Intereſt of 200*l.* for 6 Months is 6*l.* (accounting 6*l.* *per cent. per annum*) which is equal to the Intereſt of 600*l.* for 2 Months, wherefore the Work is right.

Queſt. 3. A Merchant hath owing him a certain Sum to be diſcharged at three equal Payments, *viz.* $\frac{1}{3}$ at two Months, $\frac{1}{3}$ at four Months, and $\frac{1}{3}$ at eight Months, the Queſtion is, what is the equated Time for the Payment of the whole Debt?

In Queſtions of this Nature (*viz.*) where the Debt is divided into unequal Parts) each of its Parts is to be multiplied by its Time, and the Sum of the Products is the Anſwer.

$\frac{1}{3}$ multiplied by	2 Months produceth	$\frac{2}{3}$
$\frac{1}{3}$ multiplied by	4 Months produceth	$1\frac{1}{3}$
$\frac{1}{3}$ multiplied by	8 Months produceth	$2\frac{2}{3}$
The Sum of the Product is		$4\frac{2}{3}$

which is $4\frac{2}{3}$ Months for the equated Time of Payment.

If inſtead of the Fractions repreſenting the Parts, you had wrought by the Numbers themſelves (repreſented by thoſe Parts) according to the firſt and ſecond Example, it would have been the ſame Anſwer; and ſuppoſe the Debt had been 90*l.* then $\frac{1}{3}$ of it is 30*l.* for each Payment, *viz.* at 2, 4 and 8 Months.

30*l.* multiplied by	2 Months produceth	60
30*l.* multiplied by	4 Months produceth	120
30*l.* multiplied by	8 Months produceth	240
The Sum of the Products is		420

which divided by 90 (the whole Debt) quoteth $4\frac{60}{90}$, or $4\frac{2}{3}$ Months, as before.

Queſt 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Months, and $\frac{1}{4}$ at 10 Months, and he agreeth with his Creditor to make one total Payment; I demand the Time without Damage to Debtor or Creditor? Work as in the laſt Queſtion, and you will find the Anſwer to be 7 Months.

Queſt 5. *A* is indebted to *B* 640*l.* whereof he is to pay 40*l.* preſent Money, 350*l.* at 3 Months, and the reſt, *viz*, 250*l.* at 8 Months, and they agree to make an equated Time for the whole Payment; now I demand the Time?

In Queſtions of this Nature (*viz.* where there is ready Money paid) you are, in multiplying, to neglect the Money that is to be paid preſent, and work with the reſt, as is before directed, and divide the Sum of the Products by the whole Debt, and the Quote is the Anſwer; for here 40*l.* is to be paid preſent, and hath no Time allowed; and according to the Rule it ſhould be multiplied by its Time, which is 0, therefore 40 times 0 is 0, which neither augmenteth nor diminiſheth the Dividend; wherefore to proceed (according to direction) I ſay.

350 by 3 Months produceth 1050
250 by 8 Months produceth 2000

The Sum of the Product is 3050

which divided by 640, the whole Debt, the Quote is $4\frac{49}{64}$ Months, the Time of Payment.

Queſt. 6, *A* is indebted to *B* in a certain Sum, half whereof is to be paid preſent Money, $\frac{1}{3}$ at 6 Months, and the reſt at 8 Months; now I demand the equated Time for Payment of it all?

Anſwer $3\frac{1}{3}$ Months is the Time of payment.

Queſt. 7. *A* is indebted to *B* 120*l.* whereof $\frac{1}{3}$ is to be paid at 3 Months, $\frac{1}{4}$ at 6 Months, and the reſt at 9 Months; what is the equated Time for payment of the whole Sum?

Anſ. at $6\frac{1}{2}$ Months.

Queſt. 8. *A* is indebted to *B* 420*l.* which is due at the End of 6 Months, but *A* is willing to pay him 140*l.* preſent, provided he can have the Remainder forborn ſo much the longer, to make Satisfaction for his Kindneſs, which is agreed upon; I deſire to know what Time ought to be allotted for the Payment of the 280*l.* remaining?

The

The Operation of this Queſtion is left to the Learner, to try his Genius, and who, in this Caſe, muſt have an Eye to the Rule of Three.

CHAP. XXX.

Exchange.

1. THE Rule of *Exchange* informeth the Merchants how to exchange Monies, Weights or Meaſures of our Country into (or for) the Monies, Weights or Meaſures of another Country, and when the Rate, Reaſon or Proportion betwixt the Money, Weights or Meaſures of different Countries is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or *Rule of Three*) to reſolve any Queſtion, wherein it is required to exchange a given Quantity of the one Kind into the ſame Value of another Kind.

2. In Queſtions of Exchange there is always a Compariſon made between the two Coins, *&c.* of two Countries (or Kinds) or of more.

3. In Queſtions where there is a Compariſon made between two Things (whether they be Monies, Weights, *&c.*) of different Kinds, there may be a Solution found by a ſingle Rule of Three, as by the following Example.

Queſt. 1. A Merchant at *London* delivered 370*l. ſter.* to receive the ſame at *Paris* in *French* Crowns, the Exchange $3\frac{1}{3}$ *French* Crowns *per l. ſterling*; I demand how many *French* Crowns he ought to receive?

In placing the Numbers, obſerve the 6th Rule of the 10th Chapter, which being done, the given Number will ſtand thus:

l.	*Crowns*	*l.*
1	$3\frac{1}{3}$	370

and being reduced according to the Rules of the 24th

As $\frac{1}{1}$ is to $\frac{10}{3}$, ſo is $\frac{370}{1}$ to $1233\frac{1}{3}$.

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* for his 370*l.* delivered at *London*.

Queſt. 2. A Merchant delivered at *Amſterdam* 587*l. Flemiſh*, to receive the Value thereof at *Naples* in Ducats, the Exchange $4\frac{4}{5}$ Ducats *per l. Flemiſh*; I demand how many Ducats he ought to receive?

The Proportion is as followeth:

l		*Ducats*		*l.*		*Ducats*
As $\frac{1}{1}$	is to	$\frac{24}{5}$,	ſo is	$\frac{587}{1}$	to	$2817\frac{3}{5}$

So I find he ought to receive 2817$\frac{3}{5}$ Ducats at *Naples*, for the 587*l. Flemiſh* delivered at *Amſterdam*.

Queſt. 3. A Merchant at *Florence* delivereth 3478 Ducatoons, to receive the Value at *London* in Pence, the Exchange at 53$\frac{1}{2}$*d. ſterling per* Ducatoon; I demand how much *ſterling* he ought to receive?

The Proportion for Reſolution is,

Ducats *d.* *Ducats* *d.*

As $\frac{1}{1}$ is to $\frac{107}{1}$, ſo is $\frac{3478}{1}$ to 186073

which is equal to 775*l.* 6$\frac{1}{12}$ for the Anſwer.

4. When there is a Compariſon made between more than two different Coins, Weights or Meaſures, there ariſeth ordinarily two different Caſes from ſuch a Compariſon.

1. When it is required to know how many Pieces of the firſt Coin, Weight or Meaſure are equal in Value to a known Number of Pieces of the laſt Coin, Weight or Meaſure.

2. When it is required to find out how many Pieces of the laſt Coin, Weight or Meaſure are equal in Value to a given Number of the firſt ſort of Coin, Weight or Meaſure.

An Example of the firſt Caſe may be this, *viz.*

Queſt. 4. If 150 Pence at *London* are equal to 3 Ducats at *Naples*, and 4$\frac{4}{5}$ Ducats at *Naples* make 34$\frac{1}{2}$ Shillings at *Bruſſels?* then how many Pence at *London* are equal to 138*s.* at *Bruſſels? facit* 960*d.*

The Queſtion may be reſolved by two ſingle Rules of Three. For firſt I ſay,

If $\frac{1}{1}$ Ducats at *Naples* make 150*d.* at *London*, how many Pence will 4$\frac{4}{5}$ Ducats make? *Anſwer* 240*d.*

By the foregoing Proportion we have diſcovered, that 4$\frac{4}{5}$ Ducats at *Naples* make 240 Pence at *London*; and by the Tenor of the Queſtion we ſee that 4$\frac{4}{5}$ Ducats at *Venice* make 34$\frac{1}{2}$ Shillings at *Bruſſels*; therefore 240*d.* at *London* are equal to 34$\frac{1}{2}$*s.* at *Bruſſels* (for the Things that are equal to one and the ſame Thing, are alſo equal to one another) wherefore we have a Way laid open to give a Solution to this Queſtion by another Single Rule of Three, whoſe Proportion is,

As 34$\frac{1}{2}$*s* at *Bruſſels* is to 240*d.* at *London*, ſo is 138*s.* at *Bruſſels* to 960*d.* at *London*; which is the Anſwer to the ſecond Queſtion.

An Example of the ſecond Caſe may be this, *viz.*

Queſt. 5 If 40*lb. Averdupois-weight* at *London* is equal to 36*lb* weight at *Amſterdam*, and 90*lb.* at *Amſterdam* makes 116*lb* at *Dantzick*; then how many Pounds at *Dantzick* are equal to 112*lb Averdupois-weight* at *London?*

Anſwer

Answer $129\frac{23}{25}$*lb* at *Dantzick*.

This Question is likewise answered by two single Rules of Three, *viz.* First I say,

As 36*lb* at *Amsterdam* is to 40*lb* at *London*.

So is 90*lb* at *Amsterdam* to 100*lb* at *London*

And by the Question you find, that 90*lb* at *Amsterdam* is equal to 116*lb* at *Dantzick*, and therefore 100*lb* at *London* is likewise equal thereunto; wherefore again I say,

As 100*lb* at *London* is to 116*lb* at *Dantzick*.

So is 112*lb* at *London* to $129\frac{23}{25}$*lb* at *Dantzick*.

By which I find, that $129\frac{23}{25}$*lb* at *Dantzick* are equal to 112*lb Averdupois-weight* at *London*,

5, There is a more speedy Way to resolve such Questions as are contained under the two Cases before mentioned, laid down by Mr *Kersey* in the third Chapter of his Appendix to *Wingate*'s Arithmetick, wherein he hath given two Rules for the Resolution of the Questions pertinent to the said Cases.

6. But I shall lay down a general Rule for the Solution of both Cases; and 1st, Let the Learner observe the following Directions in placing of the given Terms, *viz.*

7. Let there be made 2 Columns, and in these Columns so place the given Terms one over the other as that in the same Column there may not be found 2 Terms of the same Kind one with the other.

Having thus placed the Terms, the general Rule is,

Observe which of the said Columns hath the most Terms placed in it, and multiply all the Terms therein continually, and place the last Product for a Dividend; then multiply the Terms in the other Column continually, and let the last Product be a Divisor; then divide the said Dividend by the said Divisor, and the Quotient thence arising will be the Answer to the Question.

So the Example of the first of the said Cases being again repeated, *viz.* if 150 Pence at *London* make 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducates at *Naples* makes $34\frac{1}{2}$ Shillings at *Brussels*, then how many Pence at *London* are equal to 138 Shillings at *Brussels*?

The Terms being placed according to the 7th Rule will stand as followeth.

	A	B	
Pence at *London*.	150	3	Ducats at *Naples*.
Ducats at *Naples*.	$4\frac{4}{5}$	$34\frac{1}{2}$	Shillings at *Brussels*.
Shillings at *Bruss*	138		

Having thus placed the Terms that in neither Column there are not two Terms of one Kind, then observe that

th

the Column under A hath most Terms in it, therefore they must be multiplied together for a Dividend, *viz.* 150 multiplied by $4\frac{4}{5}$ produceth $360\frac{0}{5}$, which multiplied by 138 produceth $49680\frac{0}{5}$ for a Dividend; then in the Column under B there are 3 and $34\frac{1}{2}$, which multiplied together produce $207\frac{0}{2}$ for a Divisor; then having divided $49600\frac{0}{5}$ by $207\frac{0}{2}$, the Quotient is 960 Pence for the Answer, as before.

Again, Let the Example of the second Case be again repeated, *viz.* if 40*lb Averdupois-weight* at *London* make 36*lb* weight at *Amsterdam*, and 90*lb* at *Amsterdam* make 116*lb* at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112*lb Averdoupois-weight* at *London*.

The Terms being disposed according to the 7th Rule foregoing, will stand thus.

	A	B	
lb at *London*	40	36	*lb* at *Amsterdam*.
lb at *Amsterdam*	90	116	*lb* at *Dantzick*.
		112	*lb* at *London*.

hereby I find that the Terms under B multiplied together produce 467712 for a Dividend, and the Terms under A, *viz.* 40 and 90, produce 3600 for a Divisor, and Division being finished, the Quotient giveth $129\frac{3}{36}\frac{12}{00}$ lb at *Dantzick* for the Answer.

CHAP. XXXI.

Single Position.

1. NEgative Arithmetic, called the *Rule of False*, is that by which we find out a Truth, by Numbers invented or supposed, either single or double.

2. The Rule of Single Position is, when at once, *viz.* by one false Position, or feigned Number, we find out the true Number sought.

3. In the *Single Rule of False*, when you have made choice of your Position, work it according to the Tenor of the Question, as if it were the true Number sought; and if by the ordering your Position you find either the Result too much or too little, you may then find out the Number sought by this Proportion following, *viz.*

As the Result of your Position is to the Position, so is the given Number to the Number sought.

Example.

Quest. 1. A Person having about him a certain Number Crowns and, if a 4th, 3rd and 6th of them were added together

together they would make juſt 45 Crowns; now I demand the Number of Crowns he had about him?

Anſwer 60 Crowns

To reſolve this Queſtion, I ſuppoſe he had 24 Crowns (or any other Number that will admit of the like Diviſion) now the 4th of 24 is 6, and the 3rd is 8, and the 6th is 4, all which Parts, (6, 8 and 4) being added together, make but 18, but it ſhould be 45, wherefore I ſay, by the *Rule of Three*,

As 18 the Sum of the Parts is to the Poſition 24, ſo is 45 the given Number, to 60 the true Number ſought.

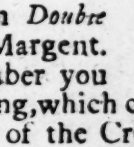
For the 4th of 60 is 15, and the 3rd of 60 is 20, and the 6th of 60 is 10, which added together make 45.

CHAP. XXXII.

Double Poſition.

1. THE Rule of *Double Poſition* is, when two falſe Poſitions are aſſumed to give a Reſolution to the Queſtion propounded.

2. When any Queſtion is ſtated in *Double Poſition*, make ſuch a Croſs as in the Margent.



3. Then make choice of any Number you think may be convenient for your working, which call your firſt Poſition, and place it at the End of the Croſs at *a*; then work with this Poſition as if it were the true Number ſought, according to the Nature of your Queſtion; then having found out your Error, either too much or too little, place it on that ſide of the Croſs at *d*, then make choice of another Number, of the ſame Denomination with the firſt Poſition (which call your ſecond Poſition) and place it on the Side of the Croſs at *b*; then work with this Poſition as with the former, and having found out your Error, either too much or too little, place it on that Side of the Croſs at *c*, and then the Poſitions will ſtand at the Top of the Croſs, and the Errors at the Bottom, each under his Correſpondent Poſition, and then multiply the Errors into the Poſition croſs wiſe, that is, multiply the firſt Poſition by the ſecond Error, and the ſecond Poſition by the firſt Error, and put each Product over its Poſition.

4. Having proceeded ſo far, then conſider whether the Errors are both alike, that is, whether they are both too much, or both too little; and if they are alike, then ſubtract the leſſer Product from the greater, and ſet the Remainder for a Dividend; then ſubtract the leſſer Error from

from the greater, and let the Remainder be a Diviſor, and the Quotient ariſing by this Diviſion is the Anſwer to the Queſtion.

5. But if the Errors are unlike, that is, one too much and the other too little, then add the Products of the Poſitions and Errors together, and their Sum ſhall be a Dividend; then add the Errors together, and their Sum ſhall be a Diviſor, and the Quotient ariſing hence is the Anſwer.

Queſt. 1. *A*, *B* and *C* built a Houſe which coſt 76*l.* of which *A* paid a certain Sum unknown, *B* paid as much as *A* and 10*l.* over, and *C* as much as *A* and *B*; now I deſire to know each Man's Share in that Charge?

Having made a Croſs, according to the ſecond Rule, I come according to the third Rule to make choice of my firſt Poſition, and here I ſuppoſe *A* paid 6*l.* which I put upon the Croſs as you ſee, then *B* paid 16*l.* (for it's ſaid he paid 10*l.* more than *A*) and *C* paid 22*l.* (for it's ſaid he paid as much as *A* and *B*) then I add their Parts.

l.				*l.*
9				*A* 6
19				*B* 16
28	120	168	288	*C* 22
---		6	9	---
56		12)	(14	Sum 44
		32	20	
76		12		76
56				44
---				---
20				Error 32

and they amount to 44; but it is ſaid they paid 76*l.* wherefore there is 32 too little, which I note down at the Bottom of the Croſs under its Poſition for the firſt Error.

2dly, I ſuppoſe *A* paid 9*l* then *B* paid 19*l.* and *C* 28.. all which added together make 56, but they ſhould make 76, wherefore the Error of this Poſition is 20, which I put at the Bottom of the Croſs under its Poſition for the ſecond Error; then I multiply the Errors and Poſition croſswiſe, *viz.* 32 (the Error of the firſt Poſition) by 9 (the ſecond Poſition) and the Product is 288; then I multiply 20 (the Error of the ſecond Poſition by 6 the firſt Poſition and the Product is 120.

Then (according to the 4th Rule) I ſubtract the leſſer Product from the greater, *viz.* 120 from 288, becauſe the Errors are both alike, (*viz.* too little) and there remaineth

168

168 for a Dividend; then I ſubtract 22 (the leſſer Error) from 32 (the greater Error) and the Remainder is 12 for a Diviſor; then I divide 168 by 12, and the Quotient is 14 for the Anſwer, which is the ſhare of *A* in the Payment.

6, Again, 2dly, if the Errors had been both too big, it had the ſame Effect, as appeareth by the following Work; for firſt, I ſuppoſe *A* paid 20*l.* then *B* paid 30*l.* and *C* 50*l.* which in all is 100*l.* but it ſhould have been no more than 76, wherefore the firſt Error is 24 too much. Again I ſuppoſe *A* paid 18*l.* then *B* muſt pay 28*l* and *C* muſt pay 46*l.* which in all is 92*l.* but it ſhould have been but 76*l.*

20 *A*		*A* 18
30 *B*		*B* 28
50 *C*	320 112 432	*C* 46
100 Sum	20 X 18	Sum 92
76 Subtract	8) (14	Subtract 76
24 Error	24 16	Error 16
	8	

wherefore the 2d Error is 16 too much; then I multiply 20 (the firſt Poſition) by 16 (the 2d Error) and the Product is 320. Again, I multiply 18 (the 2d poſition) by 24 (the firſt Error) and the Product is 432. Then, becauſe the Errors are both too much, I ſubtract 320 (the leſſer Product) from 432 (the greater Product) and there remaineth 112 for a Dividend; likewiſe I ſubtract 16 (the leſſer Error) from 24 (the greater Error) and the Difference is 8 for a Diviſor; then perform Diviſion, and the Quotient is 14, as before, for the Anſwer.

Again, 3dly, if the Errors had been the one too big and the other too little, Reſpect being had to the fifth Rule foregoing, the Anſwer would have been the ſame, as thus, I take for my firſt Poſition 6, and then the Error 32 too little; then I take for my ſecond Poſition 18, and then the Error is 16 too much; then I multiply the Poſitions and Errors croſswiſe, and the Products are 96 and 576, and becauſe the Errors are unlike, *viz.* one too big and another too little, I add the Products 96 and 576 together, and their Sum is 672 for a Dividend; I likewiſe add the Errors 32 and 16 together, and their Sum is 48 for a Diviſor; then having finiſhed Diviſion, I find the Quotient to be 14, which is the Anſwer, as was found out at the two ſeveral Trials before.

96 672 576	
6 X 18	
48) (14	
32 16	
48	

For

For Proof of this Work, I ſay,

	l.
If *A* paid ---- ----	14
Then *B* paid 14 and 10 (that is)	24
Then *C* paid 14 and 24 (that is)	38
The Sum of all is	76

which is the total Value of the Building, and equal to the given Number.

Thoſe who deſire to ſee the Demonſtration of this Rule, let them read the 7th Chapter of Mr. *Kerſey*'s Appendix to Mr. *Wingate*'s Arithmetic, *Pitiſcus* in the 5th Book of his *Trigonometria*, or Mr. *Oughtred* in his *Clavis Mathematica*.

Queſt. 2. Three Perſons, *A*, *B* and *C*, thus diſcourſed together concerning their Age; quoth *A*, I am 18 Years of Age; quoth *B*, I am as old as *A* and half *C*, and quoth *C*, I am as old as you both, if your Years were added together; now I deſire to know the Age of each Perſon?

Anſwer *A* is 18, *B* is 54, and *C* is 72 Years of Age.

Queſt. 3 A Father lying at the Point of Death, left to his three Sons, *viz.* *A*, *B* and *C*, all his Eſtate in Money, and divided it as followeth, *viz.* to *A* he gave half, wanting 44*l.* to *B* he gave $\frac{1}{3}$ and 14*l.* over, and to *C* he gave the Remainder, which was 82*l.* leſs than the ſhare of *B*; now I demand what was the Sum left, and each Man's Part?

Anſwer. The Sum bequeathed was 588*l.* whereof *A* had 250*l.* *B* had 210*l.* and *C* had 128*l.*

Queſt. 4. Two Perſons, *viz.* *A* and *B*, had each in their Hands a certain Number of Crowns, and *A* ſaid to *B*, if you give me one of your Crowns, I ſhall have five times as many as you; then ſaid *B* to him again, if you give me one of yours, then we ſhall each of us have an equal Number; now I demand how many Crowns had each Perſon?

Anſwer, *A* had 4, and *B* had 2 Crowns.

Queſt. 5. What Number is that unto which if I add $\frac{1}{4}$ of itſelf, and from the Sum ſubtract $\frac{1}{8}$ of itſelf, the Remainder will be 216?

Anſwer 192.

Many more Queſtions may be added, but theſe well underſtood will be ſufficient (even for the meaneſt Capacity) for the Reſolution of any other Queſtion pertinent to this Rule.

There may be an Objection made, becauſe we have not treated particularly upon Intereſt and Rebate; but the

Operation

Operations of ſuch Queſtions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

LAUS DEO SOLI.

A few Additional Queſtions for the Exerciſe of Learners, in the ſeveral foregoing Rules.

1. AN old whimſical Gentleman having 5 Daughters, left them a conſiderable Fortune which he bequeathed in manner following. The Sum of the Fortunes of the four eldeſt was 25000*l.* the Sum of the four laſt 33000*l.* the Sum of three laſt with the firſt 30000*l.* the Sum of the three firſt with the laſt 28000*l.* and the Sum of the two laſt with the two firſt 32000*l.* Now the Queſtion is how much was each particular Daughter's Fortune?

2. *B* and *C* working jointly can finiſh a Boat in 18 Days; with the Aſſiſtance of *A* they can do it in 11 Days. Now in what Time could *A* perform the ſame, working alone?

3. *X*, *Z* and *Y*, working together, can complete a Staircaſe in 12 Days, *Z* is Man enough to do the ſame alone in 24 Days, and *X* in 34. Now in what Time could *Y* alone get it done?

4. What Number is that, to which, if $\frac{3}{10}$ of $\frac{18}{7}$ of $\frac{14}{215}$ be added, the Total will be 1?

5. It is propoſed by an elderly Perſon in Trade, to admit a ſober induſtrious young Fellow to a Share in the Buſineſs; and, to encourage him offers, that if his Circumſtances will allow him to advance 100*l.* his Pay ſhall be 40*l. per annum*; if he be able to advance 200*l.* in Stock, he ſhall have 55*l.* a Year; and if 300*l.* he ſhall receive 70*l.* a Year. In this propoſal I deſire to know what is allowed the Young Man for his Attendance ſimply?

6. If 15 Birds coſt in all 5*s.* whereof there were Partridges at 7*d.* Quails at 5*d.* and Larks at 2*d.* How many were there of each?

7. A Mixture was made of 10 Gallons of Wine, 4 Gallons of Brandy and 12 Gallons of Water; out of the whole was drawn 8 Gallons, and as much Water put in to fill it up; then was drawn out 10 Gallons, after which was put in 6 Gallons of Wine; again there was drawn

out

out 5 Gallons, and 3 Gallons of Brandy put in, How much Wine, Brandy, and Water each is, at laſt in the Mixture?

8. There was a Fiſh caught whoſe Head was 7½ Inches long, its Tail was as long as the Head and half its Body, and the Body was exactly the Length of both Head and Tail, how long was the whole Fiſh?

9. A Man at Country Fair had a Mind to a String of the Horſes, but not caring to take them at 20 Guineas a Head, the Jockey agreed to let him have them as follows, that was, the firſt Horſe for a ſingle Farthing, the ſecond for an Halfpenny, the third for a Penny, the fourth for Two-pence, and ſo on, doubling the Price of each Horſe to the laſt; Now I demand the Price of the 25th Horſe; and of all the reſt added together?

10. There is an Army to which if you add ½, ⅓ and ¼ of itſelf and take away 5000, the Sum Total will be 100000. What is the Number of the whole Army?

11. Suppoſe a Dog, a Wolf and a Lion, were to devour a Sheep, and that the Dog could eat the Sheep in an Hour, the Wolf in ¾ Hour, and the Lion in ½ Hour; Now if the Lion began to eat ⅛ Hour before the other two, and afterwards all three eat together, the Queſtion is, in what Time the Sheep would be devoured?

12. There are 100 Stones which lie in a Line on the Ground, three Feet aſunder, and there is one employed to gather up the Stones one by one, and bring them to a Basket which ſtandeth three Feet from the firſt Stone. How many Yards muſt he go backwards and forwards in all, before he hath brought the laſt Stone to the Basket?

13. Two Boon Companions, *Gouty* and *Fat*, are to have (if they can divide it) equal Shares of eight Gallons of Wine, now lying in a Veſſel containing exactly eight Gallons: But to make this Partition they ſhall have only two other empty Veſſels, the one containing five, and the other three Gallons; how ſhall they manage to divide the ſaid Wine?

FINIS.